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RESEARCH REPORT

TOTAL QUALITY MANAGEMENT:

WILL IT WORK IN THE SYSTEM PROGRAM OFFICE?

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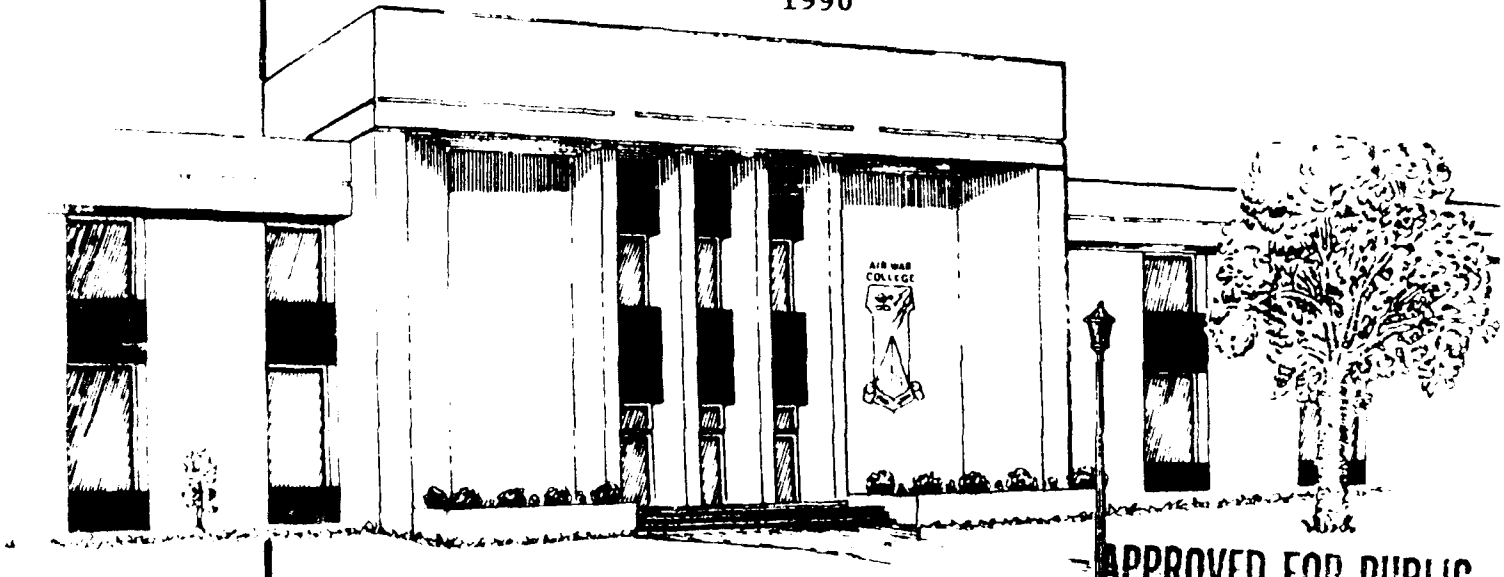

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UNITED STATES AIR FORCE
MAXWELL AIR FORCE BASE, ALABAMA

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TOTAL QUALITY MANAGEMENT:

WILL IT WORK IN THE SYSTEM PROGRAM OFFICE?

by

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A DEFENSE ANALYTICAL STUDY SUBMITTED TO THE FACULTY

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Advisor: Professor Barton J. Michelson

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EXECUTIVE SUMMARY

TITLE: Total Quality Management: Will it Work in the System Program Office? AUTHORS: Gary L. Delaney, Colonel, USAF, and Michael J. Prowse, Lieutenant Colonel, USAF

Total Quality Management (TQM) is a relatively new philosophy of management which has high-level Department of Defense support and is presently being implemented in the Air Force. In the Air Force Systems Command, weapon system development and acquisition are carried out in System Program Offices (SPOs), staffed with various functionally oriented specialists supplied to the System Program Director by functional "home offices" via a matrix management scheme. Can TQM, relying as it does on cross-functional cooperation and on processes which cross functional lines, be effectively implemented in SPOs? This study will answer this question after tracing the TQM philosophy's origins and implementation down to the SPO level and describing a recommended implementation approach.

BIOGRAPHICAL SKETCH

Colonel Gary L. Delaney (M.B.A., Florida State University) has served 18 years in various positions in the Air Force acquisition career field. He has served in System Program Offices in two Air Force Systems Command product divisions, at an Air Logistics Center in the Air Force Logistics Command, and in acquisition staff positions in the Pentagon and Headquarters, Air Force Systems Command. He also taught acquisition subjects for four years in the graduate programs at the Air Force Institute of Technology. He is a Certified Professional Contracts Manager (CPCM), a Certified Acquisition Manager - Level III, and a graduate of the Defense Systems Management College's Program Managers Course. He is also a graduate of Squadron Officer School, Air Command and Staff College, and the Air War College, class of 1990.

Lieutenant Colonel Michael J. Prowse (M.S., Troy State University) has 15 years experience in transportation and acquisition positions. He has served on the Headquarters, Air Force Systems Command staff, including a position in the Office of the Commander; has attended the Defense Systems Management College's Program Management Course; and has been program manager on two programs at the Electronics Systems Division of Air Force Systems Command. While there, he also served as Director of Initiatives, and his work on streamlining the acquisition process was included in the DoD Streamlining Handbook. In 1989 he was selected to be Air Force Systems Command's Research Fellow at the Center for Aerospace Doctrine, Research, and Education. He is a graduate of Squadron Officer School, Air Command and Staff College, and the Air War College, class of 1990.

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CHAPTER I

INTRODUCTION

United States industries have rediscovered quality! After a period of increasing competition from Japanese, German, and other foreign products, those industries which have decided to try to meet and beat the competition have done so by improving the quality of their products while keeping costs low enough to be competitive. We hear from Zenith that "the quality goes in before the name goes on." We are told that, at Ford, "Quality is Job 1." Neiman-Marcus refers to itself as "The Store of Quality and Superior Values." For Quaker State products, "The Q Stands for Quality."

Most of us in the United States now know the general, sad story of how the U.S. was the "teacher" of quality, technology and manufacturing methods forty years ago, how at that time "Made in Japan" was an indication of inferior quality, and how over the next thirty years the roles were reversed. This sad story may eventually have a happy ending if more of our companies and corporations adopt not only slogans but also the actual practices that make them true. This urgently needed movement has already started and the "teacher" is now willing to listen to and learn from the "student" who applied his learning well.

In attempting to determine just what it is the Japanese have done to become so successful in building quality products, businessmen

and academics were astounded to discover that there were no magic techniques, no secret tools, no unique ethnic capability. Rather, there was an attitude, a philosophy, a way of thinking about doing their job that enabled Japanese managers to improve the processes by which they and their workers made their products. It is this philosophy that has been captured and rekindled in the many U.S. companies that have made dramatic turnarounds in the past ten years. Known by various names in the many companies that have implemented at least portions of it, the overall, all-encompassing philosophy has come to be called Total Quality Management, TQM for short, and it has now been embraced, at least in the conceptual stage, by the Department of Defense (DoD).

Many critics of DoD weapon system programs say that it certainly has not come any too early and may be too late. The many stories of deficient or defective weapon systems could be inserted here, but these systems are merely the outputs of an acquisition and production process that has allowed deficiencies and defects to remain. We can take the defective aircraft and fix it, but the process that allowed it to be produced is still operating and will no doubt produce other similar aircraft. What is needed is the disciplined desire to improve that process, and to continue to try to improve it, so that the outputs of it will be of higher quality. TQM promises to help us develop this disciplined desire to continuously improve the processes by which we make our products and provide our services.

This study looks at this promising new philosophy and attempts to answer the question: Will it work in the System Program Office?

These System Program Offices, or SPOs, are the Air Force offices charged with managing the research, development, production, and acquisition of new weapon systems and their supporting equipment for the Air Force and, in some cases, for other services also. Organized like giant project teams, these offices have some unique and substantial obstacles facing them in attempting to implement the new TQM philosophy. This study will develop and recommend an implementation plan which should enable these important acquisition offices to profit from the benefits of a strong TQM program.

Chapter II will provide the foundations and early historical development of the quality revolution we are beginning to experience. Chapter III will present the Total Quality Management, or TQM, philosophy, principles, and concepts and explain their effects on quality and productivity. Chapter IV will trace the recent evolution of TQM within the Department of Defense, down to the Department of the Air Force, and through the Air Force Systems Command to the Product Divisions of the Command at which the SPOs are located. Chapter V will look at some unique obstacles to TQM implementation in the SPOs, detail an eight phase approach to implementation that should overcome the obstacles, and then assess this recommended approach by testing it against criteria set up forty years ago by one of the pioneers of the quality movement. We conclude with an answer to our research question and some recommendations in Chapter VI.

No critical assumptions have been necessary in carrying out this study, except perhaps that DoD and the Air Force truly want to implement TQM as a means of improving quality and productivity.

Without that assumption, not only will this study have been in vain, but also the hopes and efforts of those who have worked so hard thus far in TQM's initial introduction into DoD.

The one obvious limitation of this study is that it is conducted by humans, who have a perspective shaped by their experiences and biases. We have tried to be as factual as possible and to give good references so that the reader can review the source material himself, if desired. We have relied primarily on the experience and materials of one major Product Division within the Air Force Systems Command, the Aeronautical Systems Division at Wright-Patterson Air Force Base in Ohio, since that was the lead organization for TQM implementation.

CHAPTER II

QUALITY

> The quality of a person's life is in direct proportion to their commitment to excellence, regardless of their chosen field of endeavor.
>
> Vincent T. Lombardi

Quality is not new: it has been with us since before Noah was told how to select timber, how to build a boat, and how to satisfy his customers. Noah and other craftsmen through the ages knew, as they built durable goods, one at a time, to look for straight timber, dense grains, and no knots. They knew not to cut too much away from joints because in time joints would wear and come apart. They knew when smelting iron ore not to change the temperature or the iron ore would be inferior. They gained these skills and knowledge the old fashioned way—trial and error and continuous improvement.

From Noah to the industrial revolution, craftsmanship and quality continuously improved as craftsmen passed on their knowledge to family members and other apprentices. The 19th century and the industrial revolution changed craftsmanship in the United States. We entered a new era, one that would forever change mankind. Generally, items would no longer be built one at a time. Mass production allowed the untrained immigrant to succeed in occupations that required knowledge of only a single process of the overall manufacturing process and the ability to repeat that one process over and over again. This

became known as the assembly line. Craftsmanship was replaced with a central inspection department. (1:4) A major influence on quality were the writings of Frederick W. Taylor, the father of "scientific management." (2:101) And finally, during the rapid buildup of World War II, which introduced mass production to most American manufacturers, the unskilled worker was able to perform repetitive duties with little training. (3:58)

Taylor, recognizing that craftsmanship would be different from that of a century ago, suggested that if an inspector was to be effective, he should be a master of the tasks he was inspecting. Thus, quality inspection came about and is now a recognized function. In order for the inspector to become a master in his field, he should have worked up the hierarchy, learning the trade better with each step along the way. Knowledge-based craftsmanship was a standard over the centuries, but with manufacturing becoming highly complex, quality had to become specialized. Reliance on the craftsman was replaced with reliance on the professionally trained quality expert. Quality, once a function of craftsmanship, now became a function of management. One recognized quality expert, J. M. Juran, captures this shift very well by saying "...In the days of craft shops, the master (then the chief executive officer) participated in the process of managing quality. What emerged [after the Industrial Revolution] was a concept in which upper management became detached from the process of managing for quality." (1:4)

The Quality Evolution

The evolution of quality can be divided into three periods: quality engineering, quality assurance, and strategic quality management; (1:5) and, tracked through five distinct processes: inspection, statistical quality control, reliability engineering, total quality control, and Total Quality Management. (4:1) The Quality Engineering period encompasses the emphases on inspection and statistical quality control; the quality assurance period includes reliability engineering and total quality control emphases; and the strategic quality management period is examplified by total quality management.

Quality engineering reached its peak in the late 1940s and received most of its innovation and knowledge from the Bell Telephone Laboratories and the Hawthorne Works of the Western Electric Company. This type of quality control worked until the 1950s when organizations and products became very complex.

Quality assurance forced the development of large data banks for modeling, improved reliability, reliability built into the product in the design process, reduced complexity, safety, and measurement systems. (1:5) During both of these periods the quality departments of American companies grew larger and further removed from the craft shops of a century earlier.

The last area of quality evolution we will look at in this chapter is strategic quality management. In strategic quality management, top management will take an interest in quality from the perspective that it increases profitability, is a strong perception

of the customer, and is vital to the success of the company. (4:21) To understand this evolution, and how we have come full circle, we will start at the beginning of the quality evolution and work our way forward.

Quality Engineering

To promote an understanding of what quality engineering is, we start with a definition derived from A. V. Feigenbaum's book Total Quality Control. Feigenbaum was more interested in defining Quality-Engineering Technology than pure quality engineering. But if we extract the part that addresses technology, the following remains as a definition of quality engineering: "analyzing and planning product quality in order to implement and support the quality system which will yield full customer satisfaction at a minimum cost." (5:234)

Quality engineering brought quality into the management perspective. It recognized the need for evaluation, planning, and control. It also recognized that trade-offs could be made to meet customer desires for a level of quality, and that a quality level is related to product cost. However, the literature is not altogether clear that management in the early stages of the Industrial Revolution realized that improvements in quality would reduce waste and thus increase profits.

Quality engineering comprises the first of the three periods in the quality evolution. Inspection and statistical quality control, the two primary processes associated with it, comprise the bulk of what most of still think of today when we think of quality. David Garvin,

in Managing Quality, asserted that the origin of statistical quality control can be traced to one publication in 1931: W. A. Shewhart's Economic Control of Quality of Manufactured Product, which established the scientific foundation for quality control as well as some techniques for monitoring production. Shewhart was the first to suggest ways to improve product and process. (4:6) He was a member of a prestigious group that included Harold Dodge, Harry Romig, G.D. Edwards, and Joseph Juran. Working at the Quality Assurance Department of Bell Laboratories, this group created statistical quality control and applied it to the massive manufacturing organization of the Bell System. (4:6) The first process they refined was inspection. Shewhart believed that the quality of the final product was dependent on raw materials, piece-parts, and the assembly process. Quality was lacking in a product if variability existed in any of these elements. (6:38)

Inspection

Inspection as we know it today came about because it was no longer economical or feasible to compare one part to another or to a master part. The quantity of parts, their interchangeability and their price required a better system. A key driver for inspection was the United States Ordnance System, which required munitions consistent in effects, usage, and application. On the commercial side, companies such as Singer and McCormick Harvesting began using inspection techniques to ensure conformance and interchangeability. Since these companies were mass marketing their products, their parts had to be interchangeable, and cost was a major factor in marketability. (4:3-5)

Inspection became formally recognized as a function of quality with the publication of G.S. Radford's The Control of Quality in Manufacturing in 1922. Radford asserted that inspection was a management responsibility and a function of the quality department. He stated that quality engineers should be involved in the product early in the design process; that quality personnel should be involved across departments for better coordination; and that inspection is a means to increase output while lowering cost. Inspection's purpose was to ensure conformity to established standards. As noted by Radford, "the purchaser's principal interest in quality [was] that evenness or uniformity which results when the manufacturer adheres to his established requirements". (4:5) The problem that plagued the inspection process was that when inspectors found problems, nothing was done to correct or prevent them. The recognition by Bell Laboratories that inspection lacked sufficiency drove the development of statistical quality control.

Statistical Quality Control

Statistical Quality Control is "the application of statistical techniques for measuring and improving the quality of processess." (7:24-2) Statistical quality control can be divided into process control and sampling. Both of these areas rely heavily on the use of statistical methods and began to cause the quality community to move away from the focus of "controlling quality" to that of "measuring and predicting quality."

Process Control. Shewhart captured the essence of what process control is about. He realized that mass produced parts would vary in dimension, weight, and other characteristics regardless of whether they were made by the same machine or the same person. Shewhart had discovered variability! (4:6) Materials, people, and process would all vary to some degree—not much, but each would be a little different. Understanding of this variability between manufactured parts comes from knowing its causes. Variability is found in two distinct areas: the first, unrelated to the design process, includes such things as changes in schedule, new procedures, differing methods, faulty materials and poor workers; the second is from the design process, and it includes procedures and methods, the level and quality of the labor and leadership, and the environment. (8:27) With the knowledge that some variation would exist no matter what was done, the quality function was forced to develop tools that would measure, predict, and manage variability.

Feigenbaum in Total Quality Control has an excellent section on process control. What Feigenbaum concludes is that process control tools are just that—tools developed through practical experience by quality engineers at various manufacturing plants, especially the Bell system, to meet differing needs as they arose. These tools became standard practice techniques, were passed around, and were eventually picked up by the education system and taught to new quality engineering students. These standard practice techniques can be divided into four distinctive categories, as shown in Table 1:

1. process quality analysis

2. in-process control

3. implementation of the quality program plan

4. quality effectiveness audit

PROCESS CONTROL ENGINEERING TECHNIQUES

PROCESS QUALITY ANALYSIS

MACHINE AND PROCESS CAPACITY ANALYSIS
PROCESS RELIABILITY MATURITY ANALYSIS
QUALITY MEASUREMENT EQUIPMENT CAPACITY AND REPEATABILITY RESULTS
ANALYSIS OF PILOT RUN RESULTS
INCOMING MATERIAL TESTING, INSPECTION, AND LABORATORY ANALYSIS
NONDESTRUCTIVE TEST AND EVALUATION
PRODUCTION TESTING
SORTING INSPECTION
PROCESS VARIATION ANALYSIS
ANALYSIS OF VARIABLE QUALITY COST PERFORMANCE
TEST DATA ANALYSIS
SCRAP AND REWORK ANALYSIS
FIELD COMPLAINT ANALYSIS

IN-PROCESS CONTROL

VENDER RATING AND VENDER PERFORMANCE RATING
STRUCTURE TABLE CONTROL
CONTROL CHARTS
WORK SAMPLING

IMPLEMENTATION OF THE QUALITY PLAN

USE OF MANUALS AND STANDARD INSTRUCTIONS
INTERPRETATION OF DRAWINGS, SPECIFICATIONS, AND QUALITY PLANNING
TEMPORARY QUALITY PLANNING
FIRST PIECE INSPECTION
DISPOSITION OF DISCREPANT OR NONCONFORMING MATERIAL

QUALITY EFFECTIVENESS AUDIT	TECHNIQUE
TO MEASURE EFFECTIVENESS OF PRODUCT CONTROL	PRODUCT AUDITS
TO MEASURE EFFECTIVENESS OF QUALITY PLANNING AND EXECUTION	PROCEDURES AUDIT
TO MEASURE EFFECTIVENESS OF QUALITY SYSTEM AND EXECUTION	QUALITY-SYSTEMS AUDIT
TO MEASURE EFFECTIVENESS OF SPECIFIC QUALITY PROBLEM AREAS	OTHER AREAS OF QUALITY AUDIT

TABLE 1. Process Control. These techniques can be used to measure almost any product or function.

Shewart was refining his work on process control at the same time Harold Dodge and Harry Romig were working on another equally important component of statistical quality control—sampling. The Bell system played a key role in the maturation of quality in America.

Sampling. Sampling is a way to learn about product quality without having to inspect each item. Decisions to accept or reject are usually based on samples. To reduce error, Dodge and Romig developed sampling plans that predicted the likelihood of inaccurately accepting an unsatisfactory lot. (5:8)

Sampling was a good tool. It allowed the quality department to determine the quality levels of various lots. These levels were then averaged to determine the average outgoing quality limit (AOQL). AOQL allowed manufacturers to determine overall quality and make necessary adjustments. The concept of Acceptable Quality Level (AQL) was then created. A measure of maximum defects, AQL allowed management to provide the quality department with a "not to exceed" level of defects. If AQL was set at zero defects, the customer was assured of getting high quality parts; if AQL was set at any other level, the customer could get nonconforming merchandise. (9:24-8 thru 24-15)

When the AQL was set to a level that allowed some failed parts to be released to the consumer, the producer would pay for repairs either through field service or rework areas in the factory. If failed items were not found in the factory, he then used the customer as his final inspector. Sampling 100% of the product line can be expensive, especially when you rely on customers to find what producers do not.

Manufacturers needed something more than tools that would tell them how good or bad they performed; they needed tools that would help them guarantee the production of quality products. From this need came reliability engineering and total quality control. This period of development, which can be classified as the quality assurance era, started in the early 1950s.

Quality Assurance

In this period, quality's role moved from control to one of coordination. The process of manufacturing, from beginning to end, was brought under the quality umbrella. Designers and planners alike coordinated their activities to ensure that quality was built into the product.

Reliability Engineering

Reliability engineering was a result of the growing complexity of products, coupled with the military engineering demand that components and systems be reliable. In 1951 the DoD issued a report, Reliability of Military Electronics Equipment, issued by the Advisory Group on Reliability of Electronic Equipment, USDR&E that stated "only one-third of the Navy's electronic devices were working properly at any given time." (4:15) This and other examples from the Army and Air Force necessitated a change in the function of quality. Further, Juran made the point that as military contracts became more and more unrealistic in the development time allowed prior to delivery, many

tests and procedures normally performed were cancelled to shorten the schedule. Reliability engineering could be preventative medicine, just in case...

Slight differences exist in various definitions of reliability, but the consensus seems to be with Juran, who contends that reliability is "the probability that a product will carry out its intended function under specified conditions and for a specified length of time." (9:8-2) Juran's definition recognizes three critical points: first, that reliability is only a probability; second, that the conditions of operation must be known; and third, that reliability is measured over a period of time. These three elements form the basis of the reliability movement, forcing the development of tools to assist in measurement and prediction.

Reliability engineering's foundation is the mathematical concept of "probability theory." Three equations designed to predict the distribution of failures have been found to be relatively accurate: the Weibull distribution, which allows for varying rates depending on time, improvements, and deterioration; the exponential life function, which keeps the failure rate level throughout product life; and the bathtub curve, which reflects the maturity of the design. The bathtub curve allows for component burn in and failure early in the product life, a leveling of failure during the productive period, and an increase in the product's later life. (9:8-11 thru 8-28) Reliability measurement is reported in terms such as mean time between failure (MTBF) and mean time between critical failure. Critical failure is generally defined as one that prevents mission accomplishment.

Predicting failure was not enough to improve the poor quality found in complex military systems during the early 1950s. Needed were more investigative models which would, by function, be able to influence the design process "before the rubber ever met the road." Two such tools are failure modes and effects analysis (FMEA), and failure modes effect and critical analysis (FMECA). FMEA is a process that investigates the design, test failures at each level or opportunity (for failure), looks for causes of the component's failure (slip circuits), proposes and analyzes alternative designs, derates parts (using a higher stressed part in a lower stressed environment) and estimates the effect of proposed changes. (9:8-11 thru 8-28) FMECA adds to FMEA a critical analysis that ranks failures by criticality and probability of occurrence. With this data and field data, quality engineers began to have tools and information that helped to improve the design and reliability of the system. But, another factor also affected design and reliability — mantainability.

Maintainability is complementary to reliability and they are generally considered together. Where reliability engineers look for the causes of failure, the maintainability engineers look for the effects of failure. Their goal is to ensure that the design will facilitate a speedy repair. Maintainability is measured in time and referred to as mean time to repair (MTTR). Factors that affect it are size and location of components, frequency of scheduled maintenance, which items are serviced, and ease of service during unscheduled maintenance. Together, reliability and maintainability form a critical measure of product quality—availability.

The term availability, pushed by DoD, became an accepted framework for analysis. Availability takes into consideration such elements as repair time, standby for parts, wait time for paper work, and active use of the product.

Availability was viewed as dependent on the product, the environment, and the customer's needs. The design engineer was influenced by the reliability engineer to consider the environment in which the product would work. In the case of spacecraft, where maintenance is generally not available, the design should maximize redundancy and high levels of derated components. In the case of aircraft engines, which have down times where components can be replaced before their expected failure point, timing standards should be built into the design. Availability analysis was the beginning of a systems approach to quality applied across the product development process. (9:8-36 thru 8-37) Not unlike reliability engineering, the quality assurance doctrines of product development were being formulated. Manufacturers were concerned with the cost of quality, total quality control, and zero defects. (4:15)

Total Quality Control

The cost of quality was first brought out in J.M. Juran's Quality Control Handbook in 1951. The quality specialist needed to move away from mathematical models to something management could readily understand—cost. Juran pointed out that in any company, most functional organizations sell their function on what it costs the company or what it would cost without the function. Juran asked the

question, "what cost would disappear if all defects disappeared?" The answer represents the cost of quality.

Another way of looking at it is that quality costs are imbedded in the operation of a process, "gold in the mine." (9:5-1 thru 5-2) Looking at quality as "gold in the mine" allows quality departments to more than pay cost of quality. Quality costs are usually categorized into four divisions: prevention cost - planning and education; appraisal cost - inspection and evaluation; internal failures - scrap, rework, and repair; and external failures - warranty, field service, and liability cost. (10: 33-38) In the latest edition of Quality Control Handbook, Juran makes the point that many quality shops justified increased expenditures by claiming these expenditures would have a positive rate of return. Once management accepted the notion that quality incurs cost and participates in the return on investment, it was easier to accept the concept of total quality control.

Total Quality Control

The word "total" as associated with quality originated with the publication in 1956 of Total Quality Control by Armand Feigenbaum. He proposed that quality would be less than desirable if products were developed in a vacuum and argued that product development, manufacturing, marketing, shipping, and other divisions of the organization were just as responsible for quality as the quality engineer. Quality, said Feigenbaum, is everyone's job, horizontally, throughout the organization. (5:77-108) Management was willing to accept this view because it continued the fallacy that quality is everyone else's job.

Feigenbaum's definition of quality control provides a way to look at product development as a system. He states that total quality control is

> an effective system for integrating the quality-development, quality-maintenance, and quality-improvement efforts of the various groups in an organization so as to enable marketing, engineering, production, and service at the most economical levels which allow for full customer satisfaction. (5:6)

Notwithstanding the above, Feigenbaum did believe that management had some responsibility for quality. This is evident in his definition of a total quality system:

> The agreed companywide and plantwide operating work structure, documented in effective, integrated technical and managerial procedures, for guiding the coordinated actions of people, the machines, and the information of the company and plant in the best and most practical ways to assure customer quality satisfaction and economical cost of quality. (5:78)

The lesson of total quality control is that it is a way of managing the entire company toward customer-oriented quality activities.

In 1984 the Hughes Aircraft Company learned this lesson. After the government stopped accepting PHOENIX air-to-air missiles, Hughes management stopped all assembly operations and conducted a thorough audit of workmanship, work instructions and operating procedures. Quality became the number one priority; other objectives, such as cost and schedule, would fall into line. (11:48-51) And it worked—quality became the prime responsibility of management and the principal responsibility of marketing, engineering, production, comptroller, industrial relations, planning, and service. All divisions of this integrated organization now work toward the common goal of providing to

the customer the quality he has requested. (5:823-829) The example of Hughes was costly because quality was corrected late in the design and production process. Feigenbaum contends that organizations need to be involved early in the development process of products to avoid the potential of discovering quality problems late where it would cost more to correct. In either case, quality must be improved with the preferred time being "early on and upfront".

The over-arching concept in total quality control is that quality is looked at from the total system perspective. As Feigenbaum says, "Quality must be designed and built into a product; it cannot be exhorted or inspected into it." (5:824) This then establishes the fundamental difference between total quality control and other quality processess: every process in the organization is involved. Feigenbaum stipulates that a total quality system must be capable of performing the following 13 elements: (5:94)

1. Defined and specific quality policies and objectives. It is the responsibility of management to clearly articulate where quality fits in the organization. A quality policy statement that places the importance of quality in the same venue as that of planning, strategy, and corporate priority must be written down for all to see. In addition, the roles and responsibilities of everyone in the company must be documented so that all concerned understand their responsibility in satisying quality requirements.
2. Strong customer orientation. Every employee in the company must be working toward the common goal of providing the quality

desired by the customer at an acceptable price. Each functional area must know and understand customer requirements for operating characteristics, reliability, safety, industry standards, operating cost, and unique features. It is only through the full understanding of all concerned that a proper trade-off between cost and performance on the one hand and the value the customer places on these qualities on the other can ensure customer satisfaction.

3. All the activities necessary to achieve these quality policies and objectives. Good intentions will not get you far if after establishing the quality policies and objectives, and understanding the customer requirements, your organization is lacking in the essential quality experts, marketing representatives who understand requirements, or the people required to carry out production and service in an outstanding manner.

4. Organizationwide integration of the activities. The company must be viewed as a system, each part working in harmony with each other part toward the common objective of satisfying the customer's needs at the lowest possible cost. Systems engineering and systems management processess must be made the most efficient and willing processess in the organization so that it becomes easy to satisfy customer quality requirements the right way.

5. Clear personnel assignments for quality objectives. All personnel in the organization should have a clear understanding of their responsibility for quality, the limit and extent of that responsibility, and how they are to execute that responsibility. Also they must be informed on actions taken or projected. A good way to document assignments and responsibilities is to develop a relationship chart that lists the areas of responsibility down the left column and the function of people across the top.

6. Specific vendor-control activities. Set high standards and deal only with vendors who are willing to meet or exceed your requirements. Vendors should know without a doubt what the quality requirements are, how you categorize quality errors, and the action you expect to take when quality is missing from their product or service. Tell the vendor that he must do all quality checks and certify to you that they met your requirements, then sample a small portion to develop a quality database on that particular vendor. If you find problems with products, send them back immediately. Develop a continuous improvement program with noncompliant vendors to bring them up to your standards. Always maintain an open line of communication between you and the vendor.

7. Thorough quality equipment identification. As a total quality system works by integrating the multifunctions together, it must have not only the tools it needs to perform quality tasks, but the knowledege to identify new equipment that will assist in

measuring the level of compliance with requirements, availability predictions, and conformance to specifications. Continuous improvement in quality equipment must be the norm, and it must be budgeted for as any other capital expenditure which contributes to company profit.

8. Defined and effective quality information flow, processing, and control. An effective management information system clearly and timely communicates important quality information throughout the organization. Such a system must be able to document the quality cost, collect and portray customer concerns, and capture quality information about engineering, production, inspection, and test data. This information must be timely and easily understood by the reader. Ideally a management information system is operated in real time; that is, that as information is acquired, information is loaded into the system. This is easily done with the use of distributed computer system accessable to everyone in the company. Individuals with decision making powers in the quality process should have full and unlimited use of computer resources.

9. Strong quality-mindedness and organizationwide positive quality motivation and training. Positive attitudes constitute the first major objective for a total quality system. Attitude change should be initiated from the top of the organization and should go all the way down. Each employee must know without a

doubt that quality, craftsmanship, good designs, and outstanding service come before short- term profit. Next, the total quality system needs to reenforce the skills of the employees so they have all the tools needed. They should know what quality is, what types of quality problems can occur in their particular job and finally, they should have an understanding of which tools to use, when to use them, and what they mean. The key to this knowledge is open-mindedness to quality and to problem identification. Only through a company-wide investment in training will quality continuously improve. This objective (to develop positive attitudes) can be stated as

> The development for company personnel—in all functions and at all levels—of those attitudes, that knowledge, and those skills in quality which may contribute to company products at minimun cost consistent with full customer satisfaction. (5:94)

10. Quality cost and other measures and standards of quality performance. Quality cost should be forecast, measured, and tracked through other functional areas. Management should require the total quality control system to track cost in four areas: prevention, appraisal, internal failures, and external failures. Goals should be established to reduce the last two (internal and external failures) while encouraging the cost of the first two (prevention and appraisal) to be used adroitly. Feigenbaum has categorized the different quality costs as follows:

Cost of prevention

Quality planning
Process control
Design and development of quality information system
Quality Training and work force development
Product design verification
Systems development and management
Other prevention cost

Cost of Appraisal

Test and inspection of purchased materials
Laboratory acceptance testing
Inspection
Testing
Checking labor
Setup for test and inspection
Test and inspection equipment and material and minor quality equipment
Quality Audits
Outside endorsements
Maintenance and calibration of quality information test and inspection equipment
Product engineering reviews and shipping release
Field testing

Cost of internal failure

Scrap
Rework
Material procurement cost
Factory contact engineering

Cost of external failure

Complaints in warranty
Compliants out of warranty
Product service
Product liability
Product recall

11. Positive corrective action effectiveness. A company's effectiveness and thoroughness in a correctiveness program is a principle indicator of how well the total quality control system is functioning. Corrective action initiatives must be established

to completely and accurately identify the quality problem, verify its significance to the customer, and when the corrective action is in place, make sure that it is permanent.

12. Continuous control of the system, including the feedforward and feedback of information and analysis of results, and comparisions with the present standards. The total quality control system must continuously measure the pulse of the organization, detect any irregularities, and report up, down, and across the organization quality problems. Standards must be established early, and everyone must know them. Nor should these standards be compromised lest the integrity of the entire quality system be at risk.

13. Periodic audit of system activities. The system should be audited regularly to ensure that it can perform as required. These audits are more concerned with the system, processes, tools, and corrective action capabilites than the quality of any peice of hardware. Functions found to be weak should be immediately corrected. Additionally, the audit should find that specific quality policies and objectives are being accomplished.

Total quality control brings all parts of the product life cycle under one management umbrella to ensure that customer requirements are being satisfied by everyone. If properly applied, the system continuously forces identification of requirements across functional areas,

designed-in quality, quality checks, corrective actions, and audits.

Total quality control includes a change in the mindset of employees and managers. It sets up a system to prevent or, if not possible, to "catch" quality problems. Total quality control promotes "doing it right the first time," which reduces cost and increases productivity. (10:33-38) A slightly different approach was to expect no deficiencies to begin with. This radical approach was tagged "zero defects."

Zero Defects

The zero defects program was born of a realization that if employees had the knowledge to perform the job, and the proper tools and equipment, they only needed the desire and attention to detail to achieve the required task without defects. The zero defects program changes employee attitudes about the work they do—and what they do not do. (3:3) Zero defects originators recognized that we regularly accept less than perfection in our lives; we are satisfied with less than an "A" on a test and we accept our children finishing their homework (as opposed to doing it 100% right). In short, we accepted what Halpin called the "passing-grade complex." But while we accept this less than perfect performance from our families and ourselves, we do not accept it from professionals we deal with in our lives. We expect our car to be fixed right the first time, we expect the toaster we bought to work and we expect the doctor to prescribe the proper medicine for our ailments. Zero defects capitalizes on this "double standard," bringing the failure to meet standards to workers' attention and

pointing out that through their neglect, someone is getting less than the worker themselves would have accepted. Zero defects requests employees to pledge zero defects in their workmanship.

Zero defects is a psychologically different approach, but it does build on previous quality improvement and control approaches. Halpin says that zero defects is "a constant, conscious desire to do a job (any job) right the first time!" (3:3) Installation of a zero defects system consists of five steps or processes:

1. Presentation of the challenge (to company and workers)
2. Management backs the challenge with action of their own
3. Establish clear and unambiguous standards
4. Check conformance to standards
5. Reward conformance (3:3)

Zero defects worked when it was originated at the Martin Company on the Army's Pershing Missile program in the early 1960s. In his book on zero defects, Halpin says documentation is lacking because zero defects was not envisioned as a universally applied program. And in fact it was not until about four years later that Halpin, the Director of Quality for the Martin Company, wrote his authoritative book. The results of zero defects were beyond believability. Because of this, Martin was skeptical. Only what could be proven by the company and audited by the Army was reported. Yet, Martin reported a savings of $1.6 million and a 54% decrease in defects over a two year period for one-third of its Orlando operation. (3:16-17)

Similar to, and building on, Feigenbaum's total quality control, zero defects brings management further into the area of responsibility for quality. It does not make management totally responsible, but it gives managers responsibilities.

1. Managers must understand why they have quality problems, where these problems are, and who or what is responsible.
2. Managers must articulate in general terms what is expected of each function.
3. Managers must constantly support the zero defects program with support and personnel.
4. Managers must constantly acknowledge and reward positive compliance with the zero defects program. (3:54-55)

Both zero defects and total quality control insist that quality be viewed as a system that cuts across the entire company; that is, "Quality is everyone's job." They also insist that employee motivation cannot be ignored if "a constant and conscious desire to do a job right the first time" is to be the goal. The last major move in the quality movement was the acknowledgement that quality had strategic aspects that could be employed to enhance the company competitively and provide satisfaction to the employees.

Strategic Quality Management

Strategic quality management builds on what management and quality experts have learned in the past. Strategic quality management means

more than increasing reliability or improving workmanship—it means getting close to the customer, understanding needs and what engineers can efficiently produce. (12:63-73) It fully supports Feigenbaum's Total Quality Control and the systems application that movement brought with it. Previously developed tools, such as those in statistical quality control, are more important than ever. Inspection, process control, sampling, reliability engineering for availability, the cost of quality, and employee motivation are all incorporated in strategic quality management. Additionally, the awareness that quality can be as powerful a competitive weapon as cost, availability, and commitment to the strategiic goals of a company, is now being incorporated into the company mindset as, for example, market analysis was previously.

The significance of quality as a vital element of business can be understood better by looking at how strategy formulation occurs as compared to quality formulation. (13:44-47) Both occur at the very top of any organization. After approval, funds are allocated for a project. Both strategy formulation and quality fromulation will cause major changes to the organization. Both require and receive action horizontally and vertically throughout the organizatiom. And finally, both influence the internal and external processes of the company through the establishment of 100% conformance to standards as its goal. (14:14-17) Both have strategic importantance to the success of the company.

Acceptable quality is no longer the goal; it is, rather, continuous improvement. The goal of zero defects through employees participating with management to solve quality and process problems,

and management's commitment to quality philosophy make strategic quality management the most dynamic initiative to be incorporated into business management since the industrial revolution. In Managing Quality, Garvin succinctly summarizes a 1983 White House Conference on Productivity report on strategic quality management:

> Managing the quality dimension of an organization is not generically different from any other aspect of management. It involves the formulation of strategies, setting goals and objectives, developing action plans, inplementing plans, and using control systems for monitoring feedback and tracking corrective action. If quality is viewed only as a control system, it will never be substantially improved. Quality is not just a control system; quality is a management function. (4:38)

William Roth, Jr., in his article "The Great Shell Game," makes the point that a major misconception in the quality arena is that there is no one "best" approach to improving quality. He contends that there are four approaches: the customer-oriented approach, the manager-oriented approach, the employee-oriented approach, and the technology-oriented approach. (15:53-58) Strategic quality management focuses on each of these orientations in a systematic and focused direction. It forces companies and service organizations to look on quality improvement as long-term processes, that involve senior leadership, management, and workers at all levels in a continuous process—not a program that has a beginning, objectives, and a conclusion. (16:12-17)

One major initiative established on the concepts of strategic quality management is DoD's Total Quality Management program. DoD has played important roles over the years in advancing quality in American manufacturing. Total Quality Management continues that trend; it

should be well understood by producers, customers, overseers, legislators, and employees. Those who do not understand what is happening may miss the next industrial revolution.

CHAPTER III

TOTAL QUALITY MANAGEMENT

Total Quality Management is defined in the 4 May 1989 OASD (P&L) TQM-IPQ Fact Sheet as follows:

> Total Quality Management (TQM) is both a philosophy and a set of guiding principles that represent the foundation of a continuously improving organization. TQM is the application of quantitative methods and human resources to improve the material and services supplied to an organization, all the processes within an organization, and the degree to which the needs of the customers are met, now and in the future. (17:1)

Compare this to what Feigenbaum defined as Total Quality Control in 1951:

> An effective system for integrating the quality-development, quality-maintenance, and quality-improvement efforts of various groups in an organization so as to enable marketing, engineering, production, and service at the most economical levels which allow for full customer satisfaction. (5:6)

The difference is in the establishment of a "foundation for continuous improvement." This antithesis of the old American saying, "If it ain't broke, don't fix it" is what makes TQM the next revolution in business and in DoD. Expanding on the work of Deming, Juran, and Feigenbaum, TQM is applicable to both government and nongovernment organizations.

For TQM, quality is defined as providing the customer what he expects to receive. (18:1) One must therefore be able to define the customer and understand his desires, expectations, and preconceived notions. No customer expectation is too strenuous, too extreme, or too outrageous. Within this framework, anything is possible.

Quality expectations are achieved through a focus on five elements:

1. People
2. Equipment
3. Materials
4. Methods
5. Environment (19:57-62)

Each element is focused on the business operation and organized to meet customer expectations through a process of continuous improvement. The product can be either internal or external. External is how we think of products for customers—external to the company. Internal recognizes that some products or services are for internal use only. These internal products may be combined with others to form a product for external consumption, or they may be for internal consumption exclusively, like paychecks or quality inspections. These products, whether internal or external, will have robust designs, and when measured against standards, will be grouped close to the mean.

Philosophy, Principles and Key Concepts

TQM is an all-encompassing concept that combines technical aspects of quality, qualitative methods, and human resources into a system designed to provide the customer with the very best product. Processes and techniques are integrated within a system that is focused on continuous improvement through highly trained and motivated system members.

Principles

TQM principles serve as the foundation for managers and other system members to use in analyzing decisions and future planning actions. They provide a framework to assess outcomes and appraise behavior. TQM's nine principles guide the work done by each member of the system, and they force accountability of the system on management.

1. **Continuous Process Improvement.** This is the prime principle. It permeates the entire TQM system and is implemented through a systematic and disciplined process.
2. **Process Knowledge.** Knowledge of the process is necessary for continuous improvement. It requires a thorough understanding of each process in the system, and it promotes improvement ideas.
3. **User Focus.** User focus is both internal and external. All products and services in an organization have an internal or external user; but more importantly, to meet the needs of the external customer, internal customers must be satisfied by receiving products or services that meet conformance requirements.
4. **Commitment.** In order for TQM to work, it must have commitment from all members of the system. Most important is the total commitment of top management. TQM success is directly related to system workers' beliefs that management is committed to a continuous improvement program that reduces cost and ensures schedule compliance, customer satisfaction, and pride in individual workmanship.

5. **Top-Down Implementation.** Just as a teacher must learn a new subject before teaching it to students, managers must learn TQM as a new management philosophy before they can expect system workers to understand TQM and use it. The difference between TQM and other management approaches is that system workers are active participants in the process.

6. **Constancy of Purpose.** TQM starts with a vision established by senior leaders, and is implemented through a series of goals and objectives. Everyone's activities in the system are focused on the objectives and goals. Recognition is given to those who maintain the focus of continuous improvement. Rewards are given for positive behavior. Negative behavior, which accepts accommodation to a status quo environment, must be repaired.

7. **Total Involvement.** No individual or process is exempt from continuous improvement. This requires that processes meet conformity requirements and that individuals be fully trained and knowledgeable of their jobs and TQM techniques for continuous improvement. Less than total involvement is like "acceptable quality level"—if you accept it, you are acknowledging that some part of the system will fail and you are saying it is okay. If you plan for total involvement, you are more likely to get it.

8. **Teamwork.** Teamwork leads to efficient application of resources, correct processes, and great results. Teams support system goals through hands-on ownership of objectives that support the overall system. Teams foster improved communications and creativity, and support of the TQM principles.

9. **Investment in People.** The system's greatest asset and most significant investment is its people. Continuous improvement requires that people improve also. TQM is committed to training and education for system members. (17:4)

Management Involvement

An important fundamental of TQM is that managers at the uppermost levels of the organization must initiate a quality revolution in their organization. TQM will succeed only with the constant commitment of senior leaders. John A. Betti, vice president and member of the Board of Directors of Ford Motor Company and Chairman of the board of Ford Aerospace, relates an interesting story on how Ford got the inspiration.

> In 1980, some of our people saw the NBC documentary, "If Japan Can, Why Can't We?" where great tribute was paid to Dr Deming. Someone suggested we invite him to teach us what he taught the Japanese.
>
> But[,] Dr. Deming wasn't interested in visiting us until we convinced him we were really focused on quality and would do what was necessary to achieve important improvement.
>
> He came in January, 1981. He was much younger then, only 80. I distinctly remember some of his first visits. We wanted to talk to him about quality. He wanted to talk to us about management. We wanted to know what quality improvement tools we could use. He wanted to talk about cultural change. We wanted to know what programs would work. He wanted to discuss senior management's vision for the Company.
>
> It took time for us to understand the profound cultural transformation he was proposing. Proposing is actually too weak a word to describe his message. He viewed cultural change as a matter of life or death for American firms; not just Ford, but any enterprise. It would require a common sense of purpose and direction. And it had to start at the top. Dr Deming's questions and guidance helped us start the process of assessing what kind of company we were and what we wanted to be. (20:6)

The function of management is to ensure that organization activities are carried out as planned. If top management is totally

committed to a cultural change, and if that is transmitted throughout the organization, achievement can be realized. Without top management involvement in TQM, the cultural change will be like most other programs—it will come to an end. This idea was expressed by James Harrington when he said, "The improvement process starts with top management, progresses at a rate proportional to their demonstrated commitment, and will stop soon after they lose interest in the process." (21:1)

Continuous Improvement

The hallmark of the TQM process is continuous improvement. (17:2) The continuous improvement concept relies on developing systems and processes that build quality into a product, not inspect it in. Continuous improvement requires that improvements occur beyond an "acceptable" quality level; it puts quality first, before cost and schedule; and continuous improvement never ends. (22:3) TQM focuses on seven areas of continuous improvement:

1. Management must be of such quality that throughout the organization managers find ways to inspire, motivate, and educate employees in the continuous improvement process. Goals, tools, rewards, and training must be used properly. Training should focus on the system or process, on statistical process control techniques for all employees, and in the case of management, on skills that will empower employees to improve processes. TQM is a management system that replaces previous systems such as status-quo or quarterly financial management.

2. The quality of all processes, at all levels must be assured at all times. Managers must seek out areas that are out of control, develop measurement indicators, and systematically replace inertia with continuous, planned improvement. Each and every process must be defined, measured, and analyzed; and corrective action must be taken where needed. Ownership for each process must be established.

3. TQM focuses the efforts of the entire operation on customer satisfaction. Management must establish an atmosphere that encourages satisfaction of internal customers as a means of better meeting the expectations of its external customers. Management must establish a framework for fully understanding customer requirements (expectations), and converting these requirements into a set of fully understood conformance standards that are measurable and attainable.

4. TQM relies heavily on functional teams. The TQM organization is made up of process teams that are a part of larger functional teams that are a part of end-product teams. All teams and individuals understand their jobs and their customer's expectations. This understanding comes about through participation in process identification, measurement, evaluation, and correction.

5. TQM requires the total commitment of top management. Top managers demonstrate this commitment through the use of TQM as their management philosophy. They establish time-phased goals (long, medium, and short) and measure the organization's progress

toward these goals. They establish a decision-making process that emphasizes quality and the customer, not short-term gains. Promotions and rewards within the organization are given to those whose actions are consistent with the TQM philosophy. This demonstrates management's long term commitment and also ensures that the TQM philosophy is carried into the next generation of the organization's leadership.

6. TQM relies on statistical process control to determine where any problems are, to evaluate cause-and-effect relationships, and to assist in a systematic decision-making process designed to solve these problems.

7. TQM requires more training than other systems because TQM is an unending process. The organization is always engaged in training and education. Training starts with all employees being taught how to employ statistical process control (SPC) and process flow techniques, and how to develop visual representations of quality problems. As training continues, SPC understanding is further refined and specialized processes are taught. Managers receive training in techniques to obtain employee participation in the TQM process.

The TQM system cannot be established overnight. It takes a long time to fully implement it, and it should be developed in a time-phased approach designed to keep the attention and interest of both managers and employees.

Production Viewed as a System

Total quality management must be viewed as a total system concept that encompasses "the full scope of the product or service `life cycle' from product conception through production and customer service." (5:14) The Japanese Industrial Standard (Z8101-1981) defines quality as "a system of means to economically produce goods or services which satisfy customers' requirements." (4:191) Total quality management affects the entire industrial cycle: marketing, engineering, purchasing. manufacturing engineering. manufacturing supervision, shop operations, mechanical inspection, functional test, shipping, installation and service. (5:11) Other activities such as research and development, prototype building and testing, development drawings, and personnel management are also directly touched by TQM. Total Quality Management is a closed-loop system, as shown in Figure 1. (19:58)

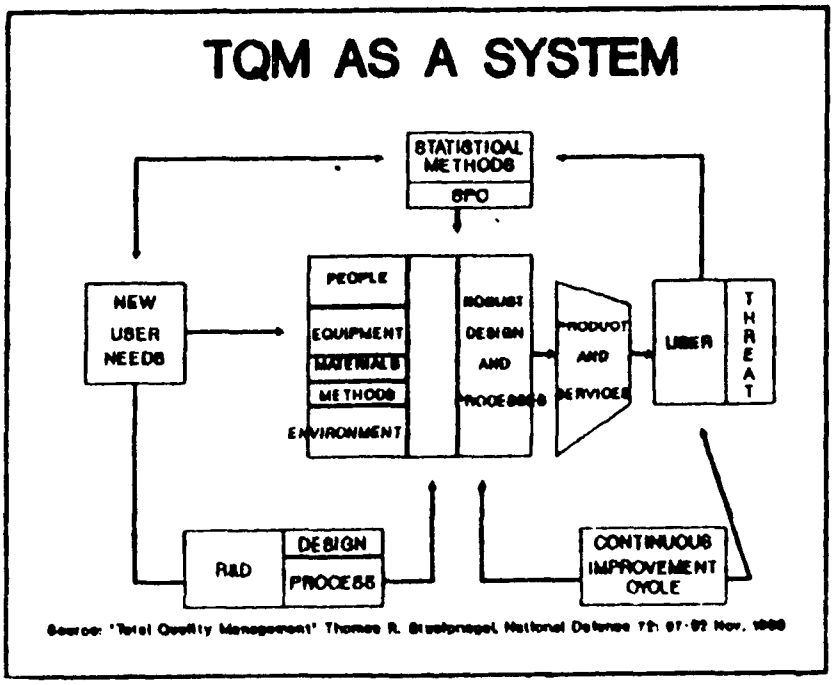


Figure 1 Total Quality Management is a closed loop system. Source: "Total Quality Management," Thomas R. Stuelpnagel, National Defense, 72: 57-62, Nov 1988.

Cost of Quality

There are two distinctive views of quality. The first is represented by the classic American school, the second by some progressive American schools and the Japanese school. The classic "production base" approach believes that increased quality means increased production cost, increased production time, and an expanded inspection system to ensure quality. (4:78-92)

The second approach views quality and cost as inversely related. It believes the cost of providing a quality product or service is less than the cost of scrap, rework, and repair. This second approach encompasses the "continuous improvement" concept and is the focus of TQM. (4:78)

TQM makes you ask, "What are the costs of quality?" and then asks you to understand how to reduce them. Juran contends that the cost of quality "is the sum of all cost that would disappear if there were no quality problems." (1:50) Table 1 represents some quality cost areas, but is not all inclusive—costs can and do change.

When and where a quality failure is detected is also important. A 100,000 percent increase in cost can occur if a component fails in the field as opposed to during inspection. Further, according to General Electric, error costs increase by an order of magnitude as components move through the industrial process. (4:79-80)

> The earlier you detect and prevent a defect the more you can save. If you can catch a two cent resistor before you use it and throw it away, you lose two cents. If you don't find it until it has been soldered into a computer component, it may cost $10 to repair. If you don't catch the component until it is in the computer user's hands, the repair will cost hundreds of dollars. Indeed, if a $5000 computer has to be repaired in the field, the expenses may exceed the manufacturing cost. (4:79)

- Cost of incoming inspection
- Cost of carrying more inventory than needed for efficient operations
- Cost of carrying lowest cost subcontractors
- Cost of imposing out-dated specifications and quality standards
- Cost of material scrap
- Cost of rework
- Cost of repair
- Cost of machine downtime
- Cost of learning curve inefficiencies
- Cost of disposition of unusable parts
- Cost of Field service operations
- Cost of material/cost adjustments
- Cost of returned material
- Cost of multiple shipments
- Cost of warranty
- Cost of test equipment and calibration
- Cost of planning quality
- Cost of training
- Cost of process control
- Cost of running quality data system
- Cost of improvement programs like Zero defects or TQM

Table 1 Quality Cost Components

Source: Quality Control Handbook by Juran (9:5-4 thru 5-6)

As companies begin to understand quality costs and processes that go into quality, cost of quality goes down and productivity goes up. (10:33-38) And as increased attention is paid to quality, productivity and customer satisfaction are increased. Total quality management must be viewed as a strategy employed to achieve success rather than a function that must be satisfied. (13:44-47) In a study

of the differences in quality between U.S. and Japanese air conditioners, David Garvin concluded that "failure rates from the highest-quality producers were between 500 and 1000 times less than those of products from the lowest". (23:82) And Norman Augustine concluded that as more "quality is built into a product, the cost of achieving quality does not increase but rather decreases. This led to Augustine's Law XII: "It costs a lot to build bad products." (23:81-82)

Quality and Productivity

Quality and productivity are components of cost in any operation. However, productivity is viewed differently because management generally has held that productivity is an indicator of organizational health. (4:84) One reason is that it has been easier to measure productivity. Yet, it is not a good measure because it has historically included all products, even those that fail. Management needs to understand the relationship between quality and productivity and the components of each.

When productivity and quality are seen as interrelating and functioning within the same closed system, any increase in defect-free output will increase both quality and productivity. And seeing the interrelationship between productivity and quality will give management a truer measure of organizational behavior and customer satisfaction. Improvements in productivity can include standardized parts, modular designs, simplified assembly, fewer engineering changes, fewer process errors, and less excess capability waiting for rework. (4:84)

Management of Outcomes versus Management of Processes

The typical management approach reacts to events that occur in the system; the TQM approach continuously works on the system. The first approach corrects problems topically, without understanding the systemic causes. In many cases the topical correction causes problems in other areas. The latter approach understands the system and how it functions; it determines the cause of problems, then corrects it. TQM formalizes the process and makes it routine. The formalization occurs in seven major areas.

1. **Planning and Goal Setting.** Planning through goal-setting attempts to forecast the future. It sets the organizational course. Effective planning forces the system to review customer requirements concerning people, equipment, methods, materials, and the environment. A good planning system is institutionalized. It forces managers to plan activities that support organizational goals through teams that support higher level and broader goals. At the very top of the organization, a vision is established to provide a purpose and a clear direction for the organization. From this vision, goals that support the vision are developed. At the next level, objectives that support the goals and are consistent with the organizatoin's vision are developed. The planning system must ensure that the goals and objectives are consistent with the vision. Through this process, quality improvement remains the nucleus of all activity.

2. **Promoting Improvement.** The best way to promote an improvement program is to live and breathe it every day. Quality and improvement should be the first things system workers think of before they take any action and the last things they think about when they evaluate the corrective action.

Philip Crosby offers us a 14-step program for quality improvement from the perspective of the quality leader who is charged with initiating it. (14:131-139)

1. Management Commitment
2. Quality Improvement Team
3. Quality Measurement
4. Cost of Quality Evaluation
5. Quality Awareness
6. Corrective Action
7. Establish an ad hoc committee for the Zero Defects Program
8. Zero Defects Day
9. Goal Setting
10. Error-Cause-Removal
11. Recognition
12. Quality Councils
13. Do It Over Again

3. **Process Improvemnt.** Process improvement is the practice of breaking down all the processes that are at work in the organization into well-defined activities. Each should have a starting point and conclude either with delivery of a product or when the activity's output becomes part of another process. Statistical process control is

employed on all of the process activities. TQM requires a statistical approach to thinking: that is, looking at a universe of data (all the data points that exist) and understanding why some of the data is within standards and some is not. Statistical process control is a good way of doing this. It should be used throughout the company initially to get everyone thinking the same way. After this thinking becomes the norm, statistical process control will decrease but the approach employees take to look at problems will not change. (19:60) In addition to statistical process control, other techniques such as process streamlining and the improvement cycle (Figure 2) are used to improve the efficiency of each process. These analysis techniques allow for accurate investigation of process objectives, requirements, and capabilities.

4. **Signals.** The right signals go a long way toward keeping the attention of system workers. Any slackening of senior management commitment will cause shock waves throughout the organization and TQM will die a sure death. The organization's educational apparatus must foster TQM in entry level and core system courses for all employees before any specialized education is provided. Those TQM advocates and system workers who exemplify the TQM philosophy should be promoted into senior positions to ensure continued success. Promotion of anyone else would signal that TQM is not the only acceptable management approach. Continuous improvement of the process and individual behavior must continuously receive the right signals.

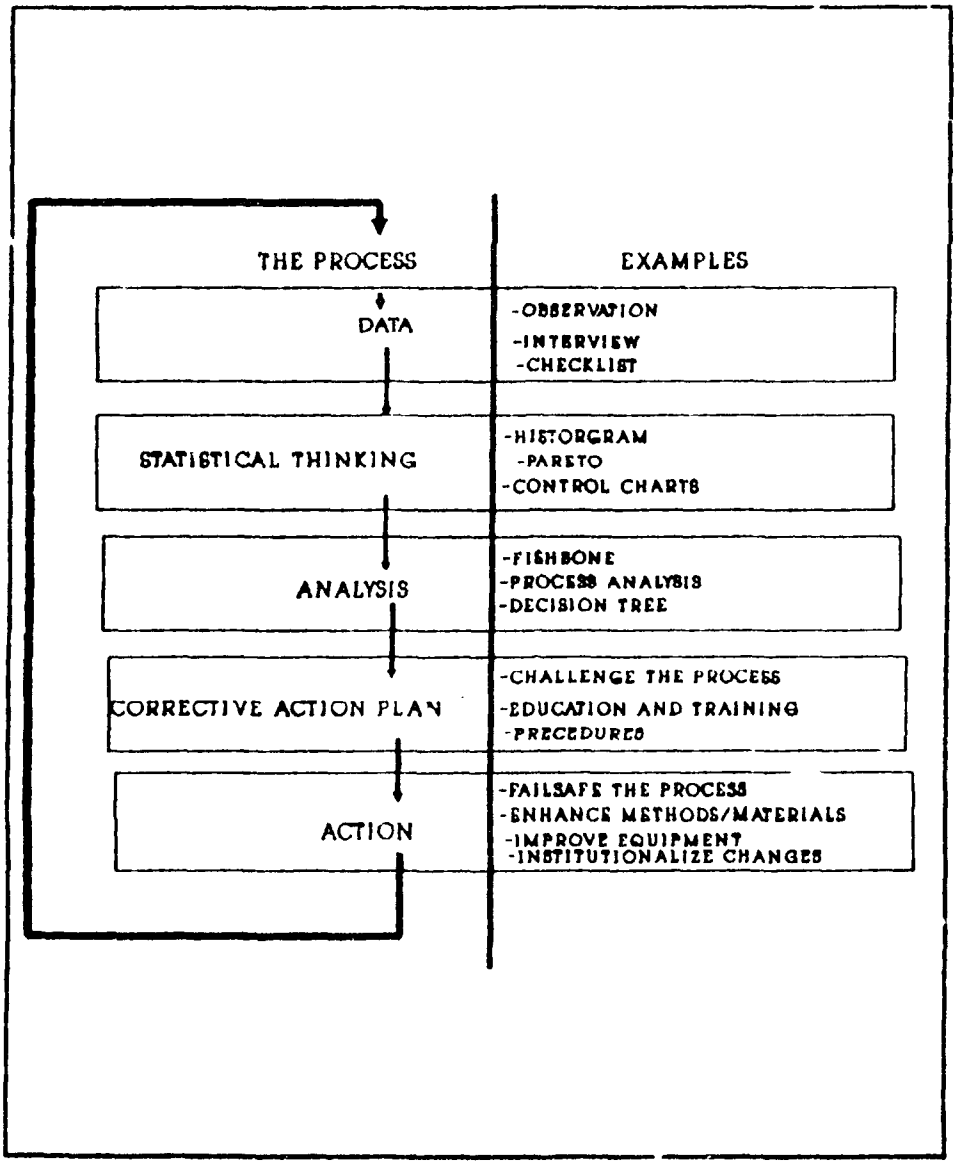


Figure 3 Improvement Cycle.
Source: DoD 500.51G, Total Quality Management Guide.

5. **Communication.** Constructive and uninhibited communication up and down the organization is critical to the success of TQM. One of the first processes reviewed is that of communication within the

organization. Any roadblocks or processes that prevent communication, such as initial hesitation in the application of TQM with the mid-level supervisor, should be eliminated. Communication systems and interpersonal lines of communication should recognize this hesitancy and work to get the information through the mid-level supervisors. One effective tool is the organizational team. The use of organizational teams will force the mid-level supervisor to feel some ownership of processes and improvements.

6. **Skill-Building.** TQM is not free, but investment in it will return great rewards. The predominant cost of TQM is in training and skills building. But training costs will be borne no matter what type of management philosophy one uses. Sadly, training is one of the first things cut in the short-term management philosophy. In TQM, training is the first item funded and the last to depart. Training and skills are developed in group dynamics, quantitative measurement techniques, and process improvement procedures. It is only through training that each individual knows his job and how to improve it.

7. **Resource Optimization.** Part of the payback in TQM is that processes and resources are less costly to operate and maintain than in a traditional organization. TQM frees individuals to look at each process and determine the optimum amount of resources at just the right time. As processes are refined and subcontractors and vendors selected on the basis of continuous improvement—not lowest cost—TQM will more than pay for itself. Processes like Just-In-Time (JIT) inventory control, process streamlining, and value added analysis will keep the system operating efficiently and make optimal use of all the organization's resources. (5:4)

Deming, Juran, Feigenbaum, and Crosby appreciated the need to go beyond the quality inspection charts and incorporate the essentials of human dynamics, organizational development, and motivational theory into TQM. The key concept is that management must take responsibility for the system. Deming noted that it is management's responsibility to work on the system, while the worker labors in the system.

The Fourteen Obligations of Top Management

The goal of TQM is quality. One aspect of ensuring quality is the elimination of obstacles that hinder quality improvement, many of which were established by management. To underscore the importance of the management change needed, Dr Deming developed "The Fourteen Obligations of Top Management." They are the basic elements taught to the Japanese in the early 1950s. Deming felt that some companies were "being carried away" with statistical methods to the detriment of the other principles. (24:43) Statistical methods should be used early in the implementation of TQM to get everyone on the same level. Their significance then diminishes. The fourteen obligations of top management are listed and discussed below: (24:ii)

1. **Create constancy of purpose toward improvement of product and service, with the aim of becoming competitive and staying in business and providing jobs.** Management must do everything possible to eliminate the quarterly profit and loss mentality, which is one of the biggest detriments to long-term growth in our country. Managers and leaders must establish a structure that will be around for the long run. The practice of moving managers

and leaders frequently must be stopped; frequent movement causes them to come to jobs with a short-term attitude and to leave with the same attitude. Promotions should be based on all their past positions in the organization, not just the last one. The continuous improvement process should also include better methods of production, better application of materials, revitalized training, retraining, continuous updating of training aids, and training funds for the future. Part of today's funds must go toward research and development to improve products, maintenance, and service; without an understanding of the customer's future requirements, an organization will not be prepared to meet the challenges.

2. **Adopt a new philosophy.** We are in a new economic age. Western Managers must awaken to the challenge, learn their responsibilities, and take on the leadership for change. According to Mann, "This goal will only be achieved if we demand high quality, dependable products, and/ or services." (24:43) Too often shortsighted managers allow lower quality and undependable products. Some managers actually plan for low quality, less dependable products, defects, workers who do not know their job, poor training, worse supervision, slipped schedules, and cost overruns. <u>If you plan for poor quality you will get poor quality.</u>

3. **Cease dependence on inspection to achieve quality. Eliminate the need for inspection on a mass basis by building quality into the product in the first place.** <u>Build</u> quality in—don't <u>inspect</u>

it in. The best way to build quality into the product is through robust design and the elimination of variability. To understand variability, one must use statistical process control techniques. Statistical design has not been used much in the United States; but where it is used extensively, that industry dominates the world market. Statistical process control utilizes such tools as flow charts, Pareto diagrams, cause and effect diagrams, run charts, scattergrams, and histograms. Workers who know how to apply statistical process control techniques are better able to find the problems an inspector would find. When the system worker finds problems and corrects them it is looked at as part of the job; when an inspector finds errors, it is considered a failure. And blame is generally assigned to the system worker, not management. As quality improves, inspection should decrease. Lack of inspections can even be used as a reward for units that are producing quality products and/or services. In addition to eliminating the reliance on mass inspection, replacing military quality standards with a statistical process control system geared to continuous improvement would go a long way to recognize producers who know quality and not just the quality standards.

4. **End the practice of awarding business on the basis of the price tag. Instead, minimize total cost. Move toward a single supplier for any one item, building a long-term relationship of loyalty and trust.** Dr Deming's feelings on this subject are presented below, where he is referring to the purchase of municipal buses from the lowest bidder.

> To have somebody that knows something about quality, they'd have to pay money. Such people are high priced. But they would save untold sums of money. It requires only a third-grade drop-out to observe which price is the lowest, and he's the one that gets the job.
>
> There's a better way today. We're in a new economic age, which requires that suppliers give statistical evidence of quality in the form of control charts and evidence that they are working on all 14 points. Quality and competition are not directly related when the goal is the low-bidder. All bidders for a product or service should be required to prove that they employ statistical process control and that the products they are offering are in statistical control. When this happens bidders will be forced to look for the best with the lowest cost of ownership, not the lowest initial price, with the highest ownership cost. Additionally, this will force bidders to develop long-term relationships with their suppliers who are in statistical control and able to provide quality parts, not low-priced parts. In the long term, high quality parts in statistical control will be low cost parts. (24:134)

5. **Improve constantly production and service system to improve quality and productivity and thus constantly decrease cost.** Don't wait for things to go wrong. Put the entire work force in a posture to find problems before the system goes out of control. Plan for a system that is forever in control, forever getting better. Retrain quality inspectors to become teachers of statistical control and advanced experiment facilitators. Make them a part of each of each work unit.

6. **Institute training on the job.** An employer cannot expect to hire fully trained employees. Company training is therfore mandatory. Training is a continuous process that matches the needs of the worker to the requirements of the system. Both benefit through increased satisfaction and productivity. Statistical methods should be used to determine what training is needed, when it is needed, and when it is complete. As training

becomes effective, product quality improves. In those rare cases where the proper training has not improved the output of a unit or individual, that unit or individual should be relocated or discharged.

7. **Institute leadership. The aim of leadership should be to help people and machines to do a better job.** Too little attention is given to training supervisors and ensuring that they are managing in statistical control. Management must teach supervisors what their jobs are and allow them to ask questions. The supervisor should serve as a coach, helping system workers solve problems. Foremen and mid-level supervisors are essential to quality education. And top leaders must recognize that continuous improvement is the means to achieve customer satisfaction. The leaders of organizations must find ways to reduce the amount of time foremen and supervisors spend doing nonproductive work. Some activities and situations that are commonly found in organizations and that might be classified as nonproductive are listed below.

weekly sign-off of time cards verifying attendance

inspection of incoming parts between divisions

clerks in approval cycle of manager's travel request

work measurement system

more quality standards

an acceptable quality level

ineffective communications systems

travel instead of teleconferencing

8. **Drive out fear, so that everyone may work effectively.** Deming estimates that probably 80% of American workers do not know and are afraid to ask what their jobs are. (24:101)

> And why is the American worker afraid? Well, somebody trained him, maybe the foreman. But he still doesn't understand what to do. Or there is some material that is unsuited to the purpose. He asks for help two or three times, but the foreman never has any time or tells him, 'Well, it's the way I told you.' So the worker doesn't wish to be a trouble maker. He works in fear. (24:101)

Just as top managers are responsible for other components of the system, so they are for supervision. Supervision that instills fear and fosters ignorance is intolerable. Like other parts of the system, supervision must be continuously improved. Supervisors must be trained in statistical process control techniques so they can identify quality costs and help workers eliminate barriers to quality. Supervisors must not be afraid to ask questions, flag problem areas, and make suggestions.

9. **Break down barriers between departments.** People in research, design, sales, and production must work as a team. The time has come to break down the walls that nurture divisions within the system. These walls prevent cooperative work between and across divisions. The lack of cross-functional assignments has contributed to worker ignorance of the total organization. This must change! Everyone must contribute to the system's goals. Multifunctional teams with common goals and objectives should be the goal of every senior executive officer, divisional manager, supervisor, foreman, and worker.

10. **Eliminate slogans, exhortations, and targets for the work force asking for zero defects and new levels of productivity.** If the company president wouldn't hang the poster in his office, it doesn't belong on the shop floor. Posters should reflect company goals, the status of the work being done, and the work that is not yet under statistical control but is getting there. Give the workers a map of where they have been, where they are, and where they are going. (A slogan like "Zero Defects" tells them what is expected but not how to get there.) "The slogan advertises to the work force that management is helpless to solve the problems of the company. Do they need to advertise? The workers already know it." (24:118)

11a. **Replace work standards (quotas) on the factory floor with leadership.** Work standards have a way of limiting improvement because the workers know that their every movement is measured and gauged. The best form of work measurement in a production operation is statistical process control. Once a process is in control and the efficiencies found, no work measurement system will improve the process. Quotas emphasize quantity over quality, leading eventually to higher cost.

11b. **Eliminate management by objective. Eliminate management by numbers. Substitute leadership.** Management by objectives is the misapplication of a good concept. Objectives are established by management and forced to lower levels where lower level objectives must be created to support the higher level ones. This imposes a requirement on system workers without giving them a

means to satisfy it. Further, the documentation required—and cheating that occurs in reporting the progress—is counter-productive. Managing through the use of vision, goals, and objectives can be effective, however, if two conditions are met: objectives should originate at the lowest levels of the organization after a clear understanding of the organization's vision is in place, and the documentation should be the same as that used to measure and maintain process control.

12a. **Remove barriers that rob the hourly worker of his right to pride of workmanship. The responsibility of supervisors must be changed from numbers to quality.** Satisfied system workers do not set out to produce bad products or provide poor service. If they do a poor job it is because the system failed to ensure that they stayed within the desired control. To know when a worker is about to fall out of control, managers must establish communication lines through which information can freely pass. These lines of communication are critical; through them come warnings of approaching dangers. Teamwork requires communication and inspires pride in daily work.

If every team of ten members was able to bring one individual's behavior closer to the group's mean, the entire system would be improved. In any group, someone has to be in the top percentage and someone in the bottom percentage—we can not change the laws of distribution. But we can reduce the variability between the top and the bottom, and we can increase the pride possessed by the lower percentages.

12b. **Abolish the annual or merit rating.** TQM offers a replacement for annual ratings: statistical process control and teamwork. Bill Scherkembach, Ford's director of statistical methods, said the performance system "destroys teamwork and cooperation, fosters mediocrity, increases variability, and focuses on the short term. In addition, it treats people like commodities and promotes fear and loss of self worth." (24:126) But, an annual performance system can work if the areas of measurement are changed to teamwork, long-term goals, and continuous process improvement. Too often, annual appraisals are based on outcomes not under the control of the individual, but rather the system. Only about 15 percent of company's processes are under the control of workers; the other 85 percent are under the control of management. Myron Tribus addressed the issue of managers selection in a presentation to the Society of Automotive Engineers in early 1983:

> Managers will not "parachute" into their positions from outside. They will be developed, over time, from within their companies through rotation around different parts of their organizations. Then the selection of top management can be made from among people who understand a company and know what it means to improve the quality of the output of the systems. This means harmonizing activities related to improving: 1) the quality of the input—information, materials, delivery, storage; 2) the design and operation of the system, including the relation between the different departments; 3) the on-the-job training of all employees; and 4) implementation of quality enhancement through feedback. (24:154-155)

Appraisal systems will work if they are consistent with the goals and objectives of the organization, and if they provide information the worker can use for continuous self-improvement.

13. **Institute a vigorous program of education and self-improvement.** TQM is effective when everyone in the organization is trained in basic statistical process methods. They must understand these methods and use them to solve problems. As the entire organization is trained in statistical process control, it frames the way the organization looks at problems and corrects quality deficiencies. Training must accomplish three objectives:

1) it must make all system workers aware of the benefits of the TQM approach;

2) it must educate all workers on the use and application of statistical tools used in TQM;

3) it must relate the TQM process to the jobs and functions that will be under their control. (22:31-32)

If the training is successful, the workers will have the tools to monitor and correct quality deficiencies and to progress toward continuous improvement system, the rewards and satisfaction of seeing the new process work on a system under their control, and the motivation to continuously improve.

14. **Put everyone in the company to work on the transformation.** As important as putting in a system for continuous improvement is the requirement that everyone in the system be involved in making it better. If there is one thing different between TQM and any other management program, it is that TQM is for everyone.

Variation: A cause for Quality Lost

Another way of understanding quality is through established requirements or standards. Neither products nor services are absolutely perfect; they vary around "target" tolerances. These tolerances are refered to as an upper control limit (UCL) and a lower control limit (LCL), which are expressions of variances from a target value. For example, in the production of a widget, the design engineer specifies that its weight shall be 10Lbs. plus or minus 1Lb. The target is 10Lbs, with the upper control limit at 11Lbs, and the lower control limit at 9Lbs (Figure 3). Anything that falls between the two "goal posts" is acceptable. The problem with this approach is that variance or variability can occur within the standard (Figure 4). This variability causes a loss of quality through "standards stacking" — not to mention increased material cost and shipping cost.

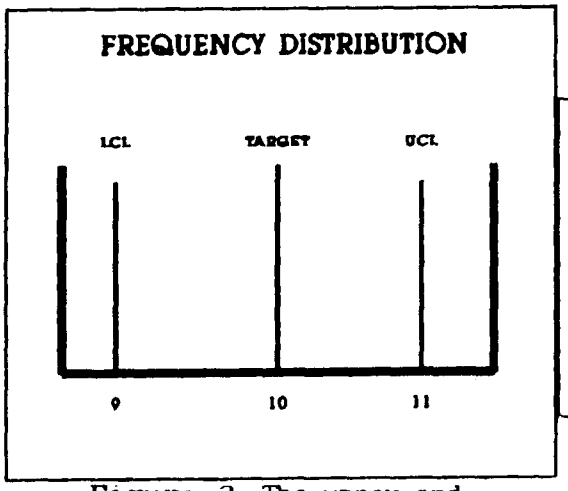


Figure 3 The upper and lower control limits are established around the target value

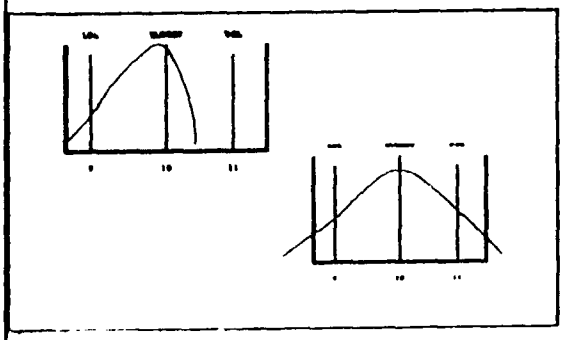


Figure 4 Any item that falls within the limits will be acceptable under a conventional quality control system

The opposite approach is what is called "loss function." The loss function approach is the creation of Genichi Taguchi, who

describes Quality as "the loss a product causes to society after being shipped, other than any losses caused by its intrinsic functions." (25:1) The focus of the manufacturing effort is on the target value—not just anywhere between the goal posts. Close conformity is achieved by reducing variability in the production process. Taguchi even notes that some of the items that fall beyond the goal posts are acceptable as long as the vast majority fall close to the target. (4:54)

Figure 5 presents both the "conventional approach" and Taguchi's "loss function." The shaded area is of higher quality because of the narrow grouping of items; the area between the goal posts and the shaded area indicates items that are within specification or tolerance but have a higher "loss function" and will be less satisfying to the consumer.

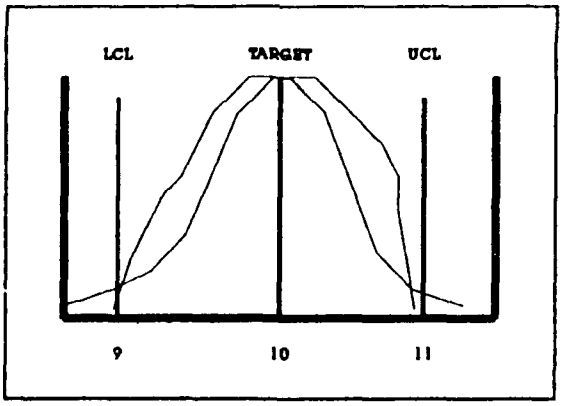


Figure 5 Taguchi's Loss Function shows higher quality through narrower variability.

The philosophy, principles and concepts introduced in this chapter have formed the basis for the TQM movement in the United States. Chapter IV will present the evolution of these ideas in the Department of Defense, as a preface to the system program office application.

CHAPTER IV

TOTAL QUALITY MANAGEMENT IN THE DEPARTMENT OF DEFENSE

The lessons and emphases on the need for quality, on its link to productivity, and on the emerging use of "total quality" management were not lost on the Department of Defense (DoD). From an inquisitive interest in the early 1980s, the DoD has slowly swung its bureaucracy's thinking toward higher quality and toward continuous improvement as a work ethic. This chapter analyzes some of the thinking which has found its way into the DoD and which forms the basis for today's application of the philosophy to various activities in DoD and in the services.

Early Commitments to Total Quality Management

The DoD did not create, pioneer, or even first embrace the TQM philosophy among the federal government agencies. The early leaders were the Forest Service in the Department of Agriculture and the Internal Revenue Service during the late 1970s. The Forest Service focused on improving the quality of its services and increasing its productivity by delegating authority to the lowest possible level and encouraging creativity in meeting users' needs. Model programs achieved 15 percent reductions in operating costs, decreased permit processing time, and an increased level of productive suggestions from employees on further ways to improve their processes. At the IRS, a Quality Council of top executives backed a movement to have regional

employees develop ways of improving their processing time and accuracy, focusing on responsiveness to the public. Whereas in 1986, 30,000 to 40,000 of the 1.2 million Federal Tax Deposit accounts received each week were kicked out by the computer due to processing errors, in 1987 only 3,000 to 4,000 had errors, even though receipts had risen to 1.5 million per week. (1:124-25)

The Naval Aviation Depot (NADEP), North Island in San Diego, a component of the Naval Logistics Center, provided the DoD's earliest success story in becoming aware of the need for implementing a TQM program. Between 1980 and 1984, two hundred top of its top managers were educated in the TQM philosophies and the need for leadership from the top of an organization. Extensive employee training was also given, emphasizing customer requirements, statistical process control, long term business planning, gainsharing, and the wise use of corrective action teams. Quality and productivity improvements have resulted in better maintenance service to F-14 customers, an increased ability to meet tight schedules, and a forecasted saving of over $1 billion by 1991 through the elimination of errors. (1:124; 2:43)

In 1987 the use of TQM was given a giant push in the acquisition arena in the form of strong support from the Office of the Assistant Secretary of Defense for Production and Logistics. Robert B. Costello, ASD(P&L), issued a memorandum in October of that year to the Assistant Secretary of the Army (Research, Development and Acquisition), the Assistant Secretary of the Navy (Shipbuilding and Logistics), the Assistant Secretary of the Air Force (Acquisition), and the Director, Defense Logistics Agency. This memo, really the first indication of DoD knowledge of and support for TQM, contained the seeds of what has become

a revolution in orientation. Some excerpts will give the flavor of the initial emphases:

> Quality has a significant bearing on the cost and field performance of defense systems and equipment. It is an important element of all aspects of the defense acquisition process. We will take an active leadership role in charting a course for emphasizing quality, which is of prime DoD interest as well as of national importance....
>
> To this end, we will integrate all of our efforts related to quality into a coordinated DoD Total Quality Management Strategy. This effort will have as its prime goal the delivery of high quality hardware and software to our soldiers, sailors, airmen, and marines. We can only achieve this through a total cultural change in DoD with respect to attention to, and continuous improvement of, quality....It is imperative that continuous quality improvement efforts be applied to this important area. (4:1)

During the next five months, Mr Costello was elevated to the position of Under Secretary of Defense (Acquisition) and convinced Secretary of Defense Carlucci of the importance of topmost leadership in getting TQM established in the acquisition arena. In March, 1988, Secretary Carlucci issued a most important memorandum, subject: Department of Defense Posture on Quality. Issued to the entire Defense Department, including the Secretaries of each Service, this memo set the tone for the serious pursuit of TQM, as these excerpts indicate:

> It is critical at this time that the Department of Defense (DoD), its contractors, and their vendors focus on quality as the vehicle for achieving higher levels of performance. The DoD budget leaves no room for solving problems which flow from poor quality. Quality is synonymous with excellence. It cannot be achieved by slogans and exhortations alone, but by planning for the right things and setting in place a continuous quality improvement process.
>
> Total Quality Management (TQM) is a concept that demands top management leadership and continuous involvement in the process activities. The successful TQM operation is characterized by an organization of quality trained and motivated employees, working in an environment where managers encourage creativity, initiative, and trust, and where each individual's contributions are actively sought to upgrade quality....
>
> I am giving top priority to the DoD Total Quality Management (TQM) effort as the vehicle for attaining continuous quality improvement in our operations, and as a major strategy to meet the President's productivity objectives under Executive Order 12552....

> Quality in weapon systems is central to the DoD mission. Therefore, I have asked the Under Secretary of Defense for Acquisition to lead the TQM thrust by implementing it as an integral element of the entire acquisition process....You should ensure that all program managers are trained to apply TQM measures in acquisition planning and throughout all aspects of program execution.
>
> ...I am convinced that as the quality-first concept inherent in TQM is shown to benefit the defense sector, it will seed a renaissance of quality throughout the United States. (5:1-2)

Attached to the memo was what was to become the basis for all of the training and programs which would begin throughout the Department—the DoD Posture on Quality statement. This posture statement showed a keen insight into the teachings of Deming and Juran, as described in earlier chapters. Figure 1 presents this important and revolutionary statement.

DoD POSTURE ON QUALITY

- Quality is absolutely vital to our defense, and requires a commitment to continuous improvement by all DoD personnel.
- A quality and productivity oriented Defense industry with its underlying industrial base is the key to our ability to maintain a superior level of readiness.
- Sustained DoD wide emphasis and concern with respect to high quality and productivity must be an integral part of our daily activities.
- Quality improvement is a key to productivity improvement and must be pursued with the necessary resources to produce tangible benefits.
- Technology, being one of our greatest assets, must be widely used to improve continuously the quality of Defense systems, equipments and services.
- Emphasis must change from relying on inspection, to designing and building quality into the process and product.
- Quality must be a key element of competition.
- Acquisition strategies must include requirements for continuous improvement of quality and reduced ownership costs.
- Managers and personnel at all levels must take responsibility for the quality of their efforts.
- Competent, dedicated employees make the greatest contributions to quality and productivity. They must be recognized and rewarded accordingly.
- Quality concepts must be ingrained throughout every organization with the proper training at each level, starting with top management.
- Principles of quality improvement must involve all personnel and products, including the generation of products in paper and data form.

Figure 1. DoD Posture on Quality. (5:3)

With this grounding the DoD next put together a draft TQM Master Plan which was distributed to all services and commands for review and comments. For many in the field, this was the first detailed look at what DoD had in mind and even this plan was still very much at a macro-, overview level. The details of actual incorporation into everyday activities would be left to the commands.

The TQM Master Plan, released in August 1988, came out strongly in defining TQM as a strategy for continuously improving performance at every level, with the overriding objective being to increase user satisfaction. As if to answer the potential question, "Does this really apply to me?", the plan also indicated its scope:

> Everything that DoD does, every action that is taken, every system that exists, involves processes and products that can be improved or services that may be performed more efficiently. This concept applies to all products and services including those ultimately employed on the battlefield. TQM affects everything DoD does, produces, or procures. It demands commitment and professional discipline. It relies on people and involves everyone. (6:1)

The Total Quality Management Master Plan provided a series of long-range and short-range goals which should be achieved. These are vital as analytical tools to assess the success or failure of the program after certain periods of time.

Long-range goals were meant to be achieved in between three to seven years, indicating to us when the philosophy had matured. As such they represent the long-term changes we expect to see in the organization's culture after TQM implementation. The long-range goals were:

1. Establish TQM as a way of life.
2. All DoD personnel directly doing continuous process improvement.
3. Widespread Defense industry implementation of continuous process improvement.
4. Congressional understanding of and support for TQM. (6:3-4)

The mid-range goals are those needed to support the achievement of the long-range goals and should be accomplished between one and five years after initial implementation. These goals were:

1. Establish and implement policy deployment mechanisms.
2. Harmonize DoD Directives/Regu;ations/Instructions and TQM.
3. Eliminate barriers to TQM implementation.
4. Implementation commitment by major Defense contractors, with "critical mass" achieved in at least the to 25 contractors.
5. DoD Acquisition personnel use TQM principles and practices in dealing with industry.
6. Develop, produce, acquire, and promulgate a standard set of TQM training materials.
7. Establish a mature, functioning staff of facilitators.
8. Understand and coordinate with TQM efforts by other sectors of the Federal Government.
9. Develop and cultivate key congressional TQM champions. (6:5-7)

These pronouncements from DoD, along with the training of 450 top managers from the DoD and the Services in the W. Edwards Deming Quality Seminar during the same period, told the services and other DoD agencies that this new emphasis was for real. At the same time, Congress passed legislation to establish the Malcom Baldridge National Quality Award, to be given to the few companies in the United States who exhibit the most innovative or effective improvements in quality. (7:6) These revolutionary initiatives were meant to convince the acquisition community in the DoD and the contractors in the Defense industrial base that a new emphasis was needed. How the Air Force would implement this direction is discussed in the following section.

Total Quality Management in Air Force Weapon System Acquisition

The U.S. Air Force received the not-too-subtle message emanating from DoD in 1988 and quickly moved out on programs of its own to spread and implement the developing philosophy. The three acquisition commands, Air Force Systems Command (AFSC), Air Force Logistics Command (AFLC), and Air Force Communications Command (AFCC) all began working on understanding the new philosophy and making plans to incorporate it into their acquisition processes.

AFCC is a vey small acquisition command and procures only computers and associated communications equipment. Little information is yet available to describe its implementation strategy. AFLC profitted from the leadership of General Alfred G. Hansen, who quickly and enthusiastically set into motion a version of TQM he would call QP-4--Quality is People, Process, Performance, and Product. In a command of over 85,000 people, General Hansen has made significant inroads into changing the traditional thinking about providing logistics support to its customers. Details of this successful program are outside the scope of this paper, but are outlined in several articles written by General Hansen over the last 18 months. (8:33-36)

Total Quality Management in Air Force Systems Command

AFSC was also quite fortunate to have, at the time of DoD initiation of TQM, a commander who was "right for the time." General Bernard P. Randolph had previously been intimately associated with the Air Force's space program where the necessity of "doing it right the first time" and of building in quality, reliability, and endurance had enabled many of our most important satellite programs to be the successes they were. In addition, as the Deputy Chief of Staff, Research, Development,

and Acquisition on the Air Staff and then, as the Principal Deputy Assistant Secretary of the Air Force (Acquisition), he had been in a position to see the impact of quality (or the lack of it) in all of the Air Force's major acquisition programs.

General Randolph's rich acquisition background allowed him to not only understand and accept the new emphasis on quality but to anticipate and predate it also. For example, in July 1987, he issued AFCS Regulation 550-2, stressing teamwork in working towards the Command's three goals:

1. To meet our users' needs;
2. To maintain acquisition excellence; and,
3. To enhance our technological superiority. (9:1)

This placement of the users' needs in the predominate position in the definition of the command's mission was to make the philosophy of TQM, which implore us to increase the quality of our processess and products to better serve our customers, both internal and external, much easier to assimilate into the command's thinking. General Randolph also had other personal Commander's Policies which truly anticipated the coming TQM philosophy. For example, AFSCR 550-4 entitled "Teamwork" stressed the synergism to be achieved through teamwork, which would also be a prime ingredient of TQM. (10:1) AFSCR 550-10 entitled "Focus on the User" desired the command be characterized by "...a fervent interest in, knowledge of, and responsiveness to our users' environments, concerns, and requirements." (11:1) AFSCR 550-11 entitled "Give the User Value" reminded that "...we exist to support the user and to put combat capability in the hands of the men and women of the operational commands...The single measure of support to users is the value in the systems we ultimately place in their hands." (12:1) And AFSCR 550-25 entitled "Competition Advocacy" noted that competition was important

because "it saves us money, improves quality, enhances supportability, and establishes an efficient industrial base...." (13:1) These policy statements, most of which predate DoD's initiation of TQM, helped set the tone for embracing the coming philosophy.

In May 1988, after being exposed to and tasked by the DoD policy announcements discussed above, General Randolph issued an *implementing* letter to the 53,000 personnel in the command. In it, he noted the similarity with the AFSC mission and left no doubt that he was expecting full acceptance and implementation. Portions of his letter are worth repeating here:

> ...Four essential factors are key to TQM success: Management Commitment, People Development, Quality Excellence, and User Satisfaction. The ultimate goal of TQM is a quality-equipped, quality-supported, fighting force. I make no distinction between TQM and the mission of Air Force Systems Command....
>
> I am committed to make TQM "a way of life" in AFSC. This is vital to our mission success. It will be an iterative process, demanding a long-term commitment to, and focus on, obtaining measurable increases in the quality of our delivered systems. It will take resolute leadership. I am confident we will successfully meet this challenge. (14:1).

At General Randolph's direction, a small task force of HQ AFSC personnel developed a Total Quality Management/Could Cost Plan and issued it in August 1988. (Could Cost was a separate but complementary program mandated by Congress focusing on methods of reducing development and production costs.) This plan outlined the general methodology to be used within the command for implementation of TQM. It concentrated on five objective areas:

1. Awareness of and commitment to TQM
2. Development of teamwork with industry
3. Development of tools and techniques
4. Application of TQM to programs
5. Assessment of effectiveness (15:1)

The plan also designated the B-2 program at the Aeronautical Systems Division, Wright-Patterson AFB to be the Air Force's demonstration program

for TQM implementation. (The Army had selected the Bradley Fighting Vehicle program and the Navy, the D-5 Trident Missile program.) This selection put the focus on ASD, the largest product division within Air Force Systems Command, for developing the paradigm for the U.S. Air Force.

Total Quality Management at Aeronautical Systems Division

At Aeronautical Systems Division (ASD) the challenge of developing the lead TQM program for the Command and managing the B-2 program with it as the Air Force prototype was welcomed by the commander, Lt Gen John M. "Mike" Loh. As a former user of ASD's products in the Tactical Air Command, he empathized with the need for better quality and the need to satisfy the customer. He immediately appointed a Colonel with a small staff to be his TQM focal point, and he contracted with a consultant company specializing in the training and structuring of the program that would be needed. This company, the Cumberland group, began as a training segment of Armco Steel Corporation in Middletown, Ohio; but, after developing a quality improvement program for Armco Steel that proved very successful, it spun off into a separate training group to do the same for other customers who had heard of Armco's success. Together, the Cumberland Group, General Loh, and his Assistant to the Commander for TQM developed the nucleus of ASD's approach.

ASD's TQM Plan, dated 30 November 1988, provides good examples of the top down leadership called for in all descriptions of successful programs. It indicates that ASD implementation will focus on incorporating TQM into three different areas: (1) in conducting its own internal operations; (2) in incentivizing its suppliers to produce a quality product, and (3) in motivating the aerospace defense contractor community to adopt a TQM type approach to their own operations. If these

can be accomplished, then ASD can realize its overall objective: "...to deliver products and services to the user that consistently conform to requirements that satisfy his needs and expectations." (16:1)

The ASD internal effort was begun first, both because ASD personnel had to be educated in the TQM philosophy before being able to move on to other steps and because "putting its own house in order" was a necessary precondition to expecting the contractors to change. Strong leadership from the Commander and extensive training in the culture of quality were the foundations upon which the effort began. In addition, a vision of the purpose of the organization was developed and disseminated for everyone's comment and refinement. The finished product was as follows:

> We are the Aeronautical Systems Division, the center of excellence for research, development and acquisition of aerospace systems.
>
> We work together to create quality systems for combat capability to ensure we remain the best Air Force in the world and preserve the American way of life forever. (16:2)

This grand vision tells ASD personnel what it is they do, how they contribute, and why they do it. Although in final form it seems a simple statement, it was (and is for most organizations, it seems) very difficult to put into words and to achieve concensus among all personnel. It is disturbing to realize how many organizations have only a fuzzy, if any, vision of what their organization is specifically in existance for.

The next requirement was a set of principles that managers and workers could look to to understand how they were being managed. These principles should be the guideposts for actions taken and the benchmarks for measuring whether or not the actions, and the entire organization, have been successful. Based upon the goals of the TQM philosophy, the principles finally agreed upon were as follows:

1. Change the culture—make the Total Quality approach A WAY OF LIFE.
2. Commit fully to the Command's policies and goals.
3. Know and satisfy our customers' needs.
4. Delegate responsibility and authority—accept accountability.
5. Give EVERYONE a stake in the outcome.
6. Set goals, compete, measure progress, and reward.
7. Create a climate of pride, professionalism, excellence, and trust.
8. Strive for continuous improvement—make it better. (16:2)

In order to put these principles into practice, a new organization "overlay" was created to provide a structure for the pursuit of TQM activities. Figure 2 shows the structural overlay that was developed for use in each program office. The mechanics of this structure will be discussed in Chapter V, but the important point here is that it was designed to focus attention on quality and on the organization's processes and to give everyone a chance to help improve the organization.

In order to carry out the new responsibilities to be expected of them, both management and working level employees were seen to need a series of training sessions, at various points in the implementation period. Before initiation of training, however, each organization's people were given opportunities, through surveys, focus group discussions, and interviews, to express their opinions and attitudes towards the mission and organization. These diagnostics form the starting point for executive level management to analyze the state of their organization. The Executive Action Workshop, the first training session, allows the top level of management in the organization to review the fundamentals of TQM, develop a vision and a set of goals for their organization, study the

STRUCTURE
EACH ORGANIZATION

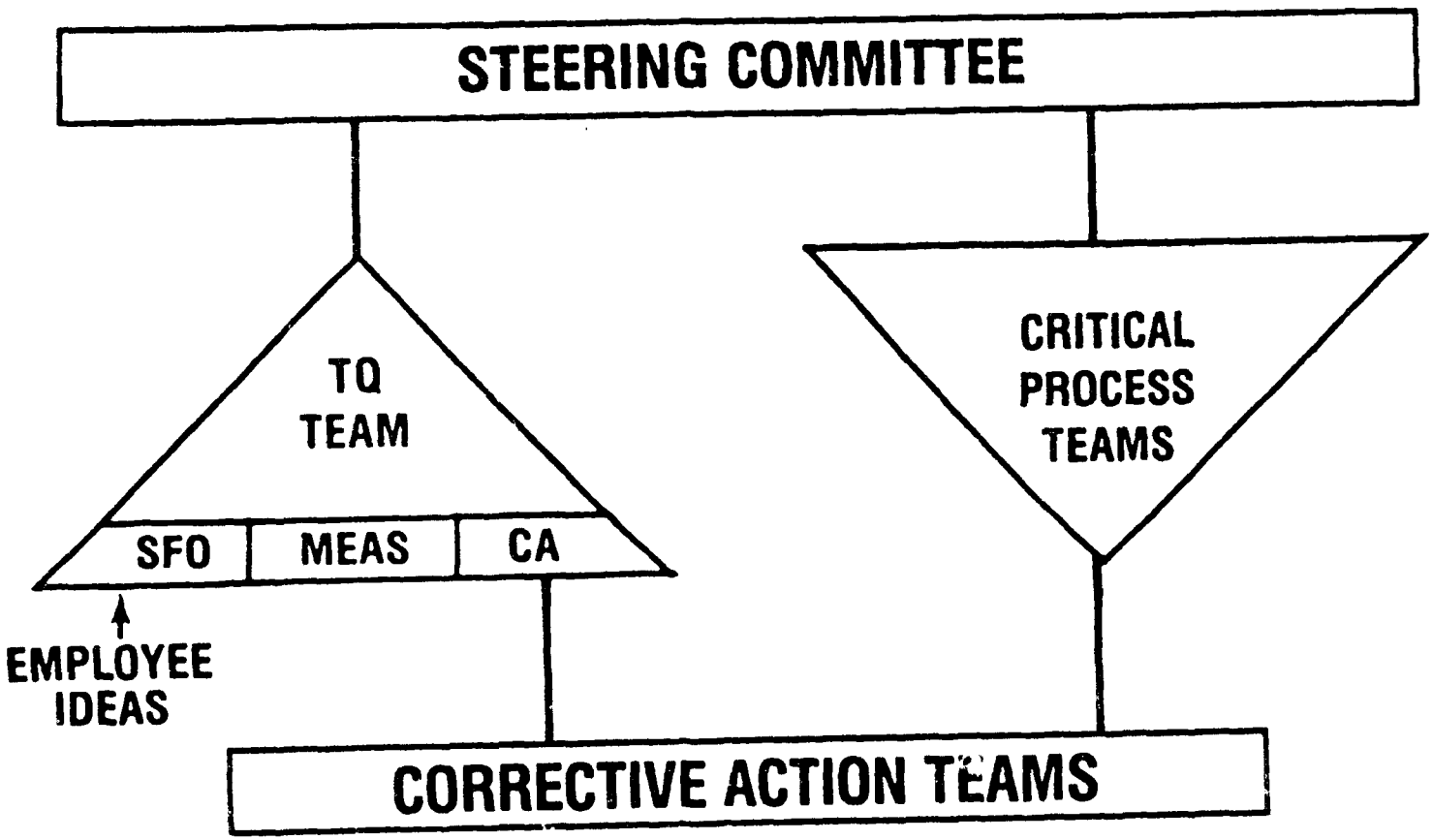


Figure 2 TQM Structural Overlay

current state of the organization as seen by the dignostics gathered from the employees, and map out a strategy for overcoming the obstacles and improving quality and productivity. Later, the Manager Action Workshop allows the middle management of the organization to do the same from their perspective. After volunteers have been selected to form the Total Quality Team, they are trained in TQ fundamentals and in how to get new ideas flowing, how to measure and correct activities in their processes, and how to provide training to others. Critical Process Teams, formed to work on the organization's problem processes, receive training on analyzing and improving a process, on team building, and on developing and selling the solutions they develop. Finally, there is Corrective Action Team training for those who will serve on the team who implements and follows up on changes to the system.

The Assistant to the Commander for TQ was made responsible for scheduling the needed training for all ASD personnel and monitoring the contract with the Cumberland Group to provide it. Initial training alone would stretch out for over a year, so that at any time, there would be organizations who had had training and were implementing TQ programs and others which had not and were not.

An Executive Steering Committee was established at ASL, with the Commander chairing but not dominating its activities, with members being the directors of each organization in the Division. Its primary purpose was to keep the implementing activities focused on the mission and in accordance with the principles previously developed. A representative of industry was also made a member of the Steering Committee. In looking at

TQM implementation from its vantage point across all of the Product Division, it commissioned several Critical Process Teams to investigate and make recommendations for improving the Request for Proposal process, the acquisition training process, the personnel assignment process, and the process for developing incentives and overcoming obstacles in motivating industry contractors to deliver a quality product. It also directed a group to review and evaluate all ASD published guidance with an eye towards removing non-value added items.

In beginning TQM implementation, ASD provided several opportunities for discussion, feedback and refocusing efforts. The Executive Steering Committee met officially once a month, but members of the committee were also present at the Commander's staff meetings each week, where progress and problems were discussed. The Assistant to the Commander for TQM hosted two meetings each month, one with the chairmen of the program offices' steering committees, and the other with the chairmen of the program offices' TQ Teams. The purpose of these meetings were to ensure consistency of approach among all the program offices and to allow them to exchange ideas and lessons learned. In addition, since ASD was the lead Product Division for TQM implementation in the Command, there were meetings and briefings with other Product Divisions, with Headquarters AFSC, and with interested persons at the OSD level as well. ASD also worked closely with the Defense Systems Management College in putting together its DoD Executive Total Quality Management Workshop.

This chapter has outlined how the concept of Total Quality Management has been fleshed out as it has been passed down from the DoD level, through the Air Force level to Air Force Systems Command and on to the

Aeronautical Systems Division level. At each level it acquired additional specificity, yet the true implementation is yet to be discussed. Chapter V will focus on the obstacles to implementing TQM in the working level acquisition arena, on recommendations to make implementation easier, and on criteria by which we can judge our implementation plan.

CHAPTER V

IMPLEMENTING TQM IN THE SYSTEM PROGRAM OFFICE

To implement the Total Quality Management concepts which have been discussed above, individuals and organizations (groups of individuals) will be asked to think quite differently about their jobs, their roles, and their organizations than they have previously thought. Change does not come easily to some individuals nor to some organizations. Some would argue that bureaucratic, government employees and organizations might be the most difficult of all to ask to change. Some of the possible reasons for this feeling are explored in the following section; then a recommended approach for TQM implementation is presented; and finally, this approach is critiqued against criteria suggested by the founding father of the quality movement.

Obstacles to TQM Implementation

Even when the idea bringing about the change is well accepted, there is often in the organizational climate some opposition to the changes that acceptance of the new idea will bring. And, if the idea behind the need to change is not yet understood or accepted, then resistance is almost assured. Government, especially military, organizations have not always taken the time to explain the rationale behind the need for changes, relying instead on the authority of the more senior people to elicit the appropriate followership from the

less senior personnel. This latter approach will not work with the implementation of TQM, as it depends upon people's acceptance of and participation in the making of the changes. But, what resistance might there be in the program office environment? Research and experience suggest we might encounter individual and organizational obstacles.

Individual Factors as Obstacles

First, there will be resistance from the uneducated. Those who have not been exposed to the TQM principles, the need for TQM, or the problems it is designed to overcome will no doubt not understand the need to change the way they do their job or think about their organization. While they can be "ordered" to change, any such change will be short-lived and reluctantly made, since it has no basis in the individuals themselves. So, one implication for implementation is the requirement to provide education about the need for the change.

Next, there could be resistance from those who have been educated, but do not "buy into" the concepts. Some may not believe that many of the country's problems are quality-related, or that the government can operate in the same way as a successful business implementor. Or, they may see it as another example of management's pushing its work down on the workers, asking them to analyze the organization and make improvements instead of management doing so.

Next, there might be resistance from those who do or do not believe the underlying concepts but who figure that this "latest program" will not last long enough for them to put any special effort into changing behavior because of it. (17:305) These are the "typical government bureaucrats" of the scornful jokes; they will tend to "slow roll" any attempt at change or, at best, treat it with benign neglect.

The next group consists of those who may or may not understand the concepts, but who in any event, see an adverse impact on themselves of going along with the implementation. This may include a feeling of potential job loss, or restructuring with adverse results, or of having to work harder or more (or some!), or of having to learn new skills to be successful in the new environment.

Another pocket of resistance may come from those people in the organization who, whether they understand and agree or not, do not feel they have the time to implement the changes required, especially for such a demanding program as that envisioned in TQM. These may even be the most productive workers, who tend to get assigned a lot to do; or it may be mid-level management who feel they are already overworked without having to implement a new program or philosophy; or it may be those who just take a long time to do things, and thus, feel busy all the time.

These, and probably other, potential pockets of resistance are based on the individual and his or her perception of the organization and their role within it. While these obstacles are important ones and must be faced and overcome to be successful, there are also organizational factors which provide obstacles. This is especially true in the program office environment.

Organizational Factors as Obstacles

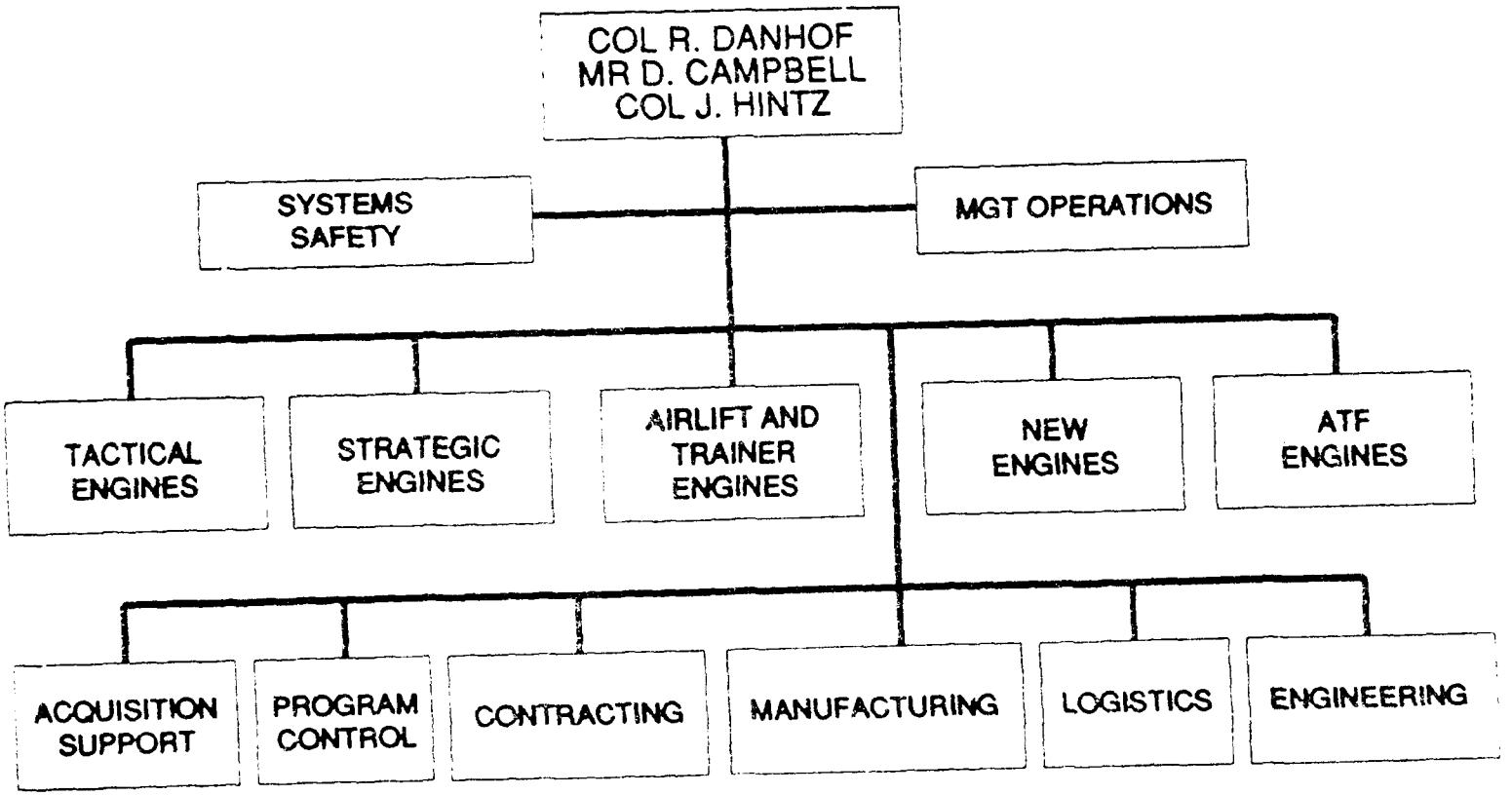
In the Air Force Systems Command, each Product Division has organized itself according to a matrix management type of organization structure. At ASD, for example, there are functional Deputates, such as Engineering, Accounting and Finance, Contracting and Manufacturing, Acquisition Logistics, etc. There are also Deputate-level organizations charged with managing acquisition programs, such as the B-1 System Program

Office (SPO), the F-15 SPO, the F-16 SPO, the Propulsion SPO, etc. These latter organizations have only a System Program Director, his deputy, and a small number of program management officers actually permanently assigned to that organization. All of the other personnel needed to carry out the mission of the SPO are "matrixed in" (in effect, loaned) to the SPO by the functional Deputies. Therefore, in employing this project team type of approach, there may be engineers or logisticians assigned to work on the B-1 program who receive their direction each day from the System Program Director but who really work for or report to the head of the Engineering or Logistics functional Deputate. The functional bosses periodically review their work, sign their performance appraisals, send them functional news and direction, and decide when they get promoted and reassigned. Yet, they physically sit with, take work assignments from, and ply their trade for, the System Program Director. In short, the functional managers "own" the functional people, but do not employ them on jobs; the SPDs use these functional resources but do not own them. Surprisingly, it works fairly well; but it can cause problems.

Unfortunately for TQM, most SPOs are large enough that they are organized, within themselves, functionally. Figure 3 shows a typical organization chart for a SPO at ASD. The SPD here has grouped his engine responsibilities into Tactical, Strategic, Airlift/Trainer, ATF, and New; however, the majority of the people needed by the program managers of these groups in order to carry out their acquisition mission, reside in the functional directorates on the bottom line. Thus, there are some engineers apportioned out to each of the engine group programs, contracting officers apportioned out to each engine group, etc. But, while these functional people work with a particular group, they all still

UNCLASSIFIED

ASD PROPULSION SPO (YZ)



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XRMO-CCT

Figure 3 Typical System Program Office Organization Structure

sit together within the walls of the engineering office, or the contracting office, etc. Each functional office makes its appropriate input at the appropriate time or times throughout the overall acquisition process, but does not have visibility into the entire process itself. Each is responsible for a separate slice of the process; only the program manager (who, remember, does not "own" them) is responsible for the whole process. This structure, and the resulting orientations of those within it, are obviously not the ideal environment for focusing on the improvement of entire processes, internal suppliers and users, corrective action teams whose solutions will spill over into four, five, or six different functional areas, etc.

In addition to the complicated structure, there are other organizational factors which will impede easy implementation of TQM. Turnover is relatively high each year in nearly every SPO, as both military and civilian employees are moved in and out. Civilians tend to be somewhat more stable than military who move to other SPOs or out of the entire Product Division, but even the civilian employees move for promotions, for broadening, or to fill a vacancy somewhere else. The result of this on an implementation plan that depends so heavily on knowledge of the entire process across functions, of who does what to whom, etc. can be devastating. The effect on TQM training is also great, as replacements must be brought up to the level of the rest of the organization quickly, trained people are lost, and team building suffers.

Each of these categories of obstacles can be very difficult to overcome, but the real problem is not realized until one notes that the two categories also interact with each other. The organizational factors can cause or exacerbate some of the individual feelings, or the individual

attitudes and opinions can make worse the coordination and cooperation requirements of the organization's structure. If other outside forces are added in (tight budget's impacts on acquisition programs, personnel hiring freezes and cut backs, Congressional criticism of cost and length of programs), it is not difficult to see that TQM will be implemented in a potentially hostile environment.

Recommended Approach for TQM Implementation

While there are few, if any, fully successful TQM philosophy implementations as of yet, there are nevertheless many other organizational interventions which have proven successful and which yield lessons learned that can be applied here. Therefore, the first step is to learn as much as possible from other similar attempts and tailor those successful actions to the TQM environment.

Lessons Learned from Other Implementations

Metz in 1984 identified three general approaches to the implementation of productivity and quality improvement initiatives: productivity/quality programs, quality of work life programs, and organizational redesigns. These approaches differ in the extent to which they are integrated into the culture and structure of the implementing organization. The first two approaches are "new programs" which require some attention and cooperation on the part of individual workers but do not require any real changes in how the organization operates. These are the ones people "wait out" until they go away or are replaced by the next attempt. Organizational redesign, however, requires a systematic plan which does lead to changes in the processes of the organization. (17:303) TQM will require this latter approach.

Another study by Siegel and Kaemmerer suggested that these five elements contributed positively to successful implementations: (1) Leadership - including displays of support and assuring the legitimacy and resource availability; (2) Ownership - participation and involvement by the people that will be affected; (3) Norms for Diversity - encouraging new and different ways of solving problems or improving processes; (4) Continuous Development - consistently seeking improvements in the problem solving approaches; and (5) Consistency - between the organization's processes and its products; a knowledge of the big picture. (18:554-561)

Peters and Waterman, in In Search of Excellence, give us some insight into what is needed by evaluating successful companies and discovering why they were successful. They note eight characteristics that would seem to provide some guidelines for this situation: (1) A bias for action - not being afraid to experiment or try new things; (2) Close to the customer - listening and learning from them; (3) Autonomy and entrepreneurship - taking the risk of being creative; (4) Productivity through People - respect for the individual and his participation and input; (5) Hands-on, value driven - involved top management, clear and understood company values; (6) Stick to the knitting - improve but stay with the business you know; (7) Simple form, lean staff - small staffs and simple (no matrix!) structures; and (8) Simultaneous loose-tight properties - centralized direction, decentralized execution. (19:13-16) It would seem that all of these characteristics would be beneficial ones for TQM implementation, although the heavily matrixed structure will probably not yield to the seventh one.

A Recommended Approach for TQM Implementation

The following paragraphs attempt to provide an integrated, phased plan for implementing TQM at ASD or in other Air Force Systems Command Product Divisions. It is based loosely on some recommendations made by Dr. Samuel Landau of the Navy Personnel Research and Development Center, (20:5–9) but the expansion of his ideas and application to ASD's situation, if irksome, should be attributed to the current authors.

The recommended approach consists of these eight phases,each of which will be discussed below:

Review Successful Implementations
Develop/Display Management Commitment
Develop Positive Work Climate & Support Structure
Provide Training for all Organizational Levels
Develop/Initiate Pilot Projects
Maintain Interest/Commitment
Institutionalize Corrective Actions
Pursue Continuous Improvement

Phase I – Review Successful Implementations has already been discussed in the previous section, but its importance cannot be overemphasized. As time and TQM effort move forward, there will be an everincreasing number of implementations to be studied for ideas on how to enhance the implementation plan. Not all attempts will have been successful and not all actions productive, but even these can be useful in helping one avoid faulty actions. Make arrangements with libraries, other product divisions and Headquarters, and academic institutions to alert you to new studies or lessons learned articles and presentations. The difficult part of this step will be deciding what might and what will not help in your situation. Tailoring the activities of others is the goal, but that will be difficult to know how to do when you are still in the preliminary stages of the implementation. Make this phase a continuing

one, running in parallel with the implementation actions, as lessons will become clearer as you approach the same implementation problem yourself.

Phase II - Develop/Display Management Commitment is a difficult but absolutely necessary step to achieve before expecting the remainder of the organization to accept the new TQM principles and philosophy. The initial step is to gain an awareness of the basics of the philosophy and how it can help your organization. The distance between awareness and commitment, however, can be longer for some managers than for others, for they are people too, with their own attitudes and opinions about change. Somehow, though, the manager who hopes to have a successful implementation must make the step to commitment, where behavioral changes are necessary as will be a reallocation of resources (money, time, people). It will also be necessary to display this commitment, once achieved, in order to motivate your top management team to do likewise. The leader must truly lead in this situation; he or she must be a dedicated role model, especially in the early stages when most of the organization is not even aware, but less committed.

Phase III - Develop Positive Work Climate and Support Structure is the step in which the stage is set for the success of the implementation. It will provide the atmosphere in which people will be asked to change the way they think about and do their job, so it is obviously a very important precurser to change. The closer the present environment has been to a permissive, participative one, the easier should be this phase. People in the organization need to know they have nothing to fear from this new TQM philosophy, that it is something that will help them and the entire organization to accomplish its mission better, and that they will be asked to help in its implementation. The details of all of this is left to the

next phase in which training will be accomplished, but for now the overall feeling conveyed to them should be one of anticipation, engendered by the leader, a feeling of "I-can't-wait-to-hear-what-the-boss-is-all-enthused-about-that-he-says-I-can-help-implement-that-will-solve-a-lot-of-the-problems-we've-been-seeing-lately." Hints can be dropped, without all of the details, about a new cross-functional, process-oriented structure that will be overlayed on the organization which will allow people from one function to tell those in other functions about their job, their contribution, their slice of the system. People usually enjoy the prospect of enlightening others as to the important role they serve, as they seldom get that opportunity.

During this phase also, top management has to further set the stage by showing all employees that they are doing some serious thinking about the organization, its direction and goals, its problems, and its number one resource, its people. The organizational climate survey and interview step should be accomplished here, both to provide diagnostics for the training sessions to follow and for the establishment of the "he-seems-to-really-want-to-know-what-I-think" feeling among the employees. A later use of the data collected here will be as a "before" picture with which to compare with later similar surveys. A draft Vision Statement and a draft list of the organization's goals should be developed and disseminated for thought and comments.

All of these actions in this phase should be directed toward establishing an "open mind" mentality on the part of the employees, a feeling of enthusiasm about what is coming, and a knowledge that they will be asked to participate in the decisionmaking and implementation of any

changes to come. If done well, this phase should make the remainder of the implementation flow smoothly; if not done well, it might only yield indifference or worse, resistance.

Phase IV - Provide Training for all Organizational Levels should be, if the previous phases have been done well, something looked forward to by the organization. There should be lots of questions, hopefully lots of interest, and, even more hopefully, lots of enthusiasm built up and ready to be satisfied by finding out what this "TQM thing" is all about.

Initial training should be focused on the awareness step and assure that all organization members learn the basics—the problems of low productivity and quality and their ramifications in a company or in a country; some previously tried programs to address the issues and why they were less than successful; an introduction to Deming's and Juran's work; a review of the Japanese methods that have been so successful; an overview of the Total Quality movement and DoD's and Air Force's pronouncements about it; and, finally, a presentation of TQM's principles, philosophy and orientation, and methodology. People should be able to take away with them, for further review and thought, TQM's principles (Continuous Process Improvement, Process Knowledge, User Focus, Commitment, Top-Down Implementation, Constancy of Purpose, Total Involvement, Teamwork, Investment in People) with perhaps a short explanation of each, such as on pages 35 to 37 above. This should help address the changes that will be expected in the organization's climate. To address the structure changes, a diagram such as in Figure 2 should be given to each person to contemplate in order to ingrain the participative features of the TQM overlay. To encourage involvement, allpersons should be told to think about volunteering for the TQ Team in the near future.

Several types and levels of training will need to be conducted. That is why most implementing organizations have sought the services of a consulting company or educational institution in the beginning. As TQM becomes well understood, DoD and the Services may well be able to create their own initial training force for less expensive initial exposure to TQM. Each Product Division should, after building a nucleus of trained people, be able to conduct its own small team training and provide refresher training as desired. As already noted above, training for the different levels of involvement will offer specialized exposure to concepts and tools needed to effectively serve on the TQ Team, on a Critical Process review team, on a Corrective Action team, and as members of top and widdle management. Each must reinforce the basics of TQM, add new knowledge for the specific training objective, and convey the feeling that the participants will be making a strong contribution to the improvement of the organization when they go back and apply their new knowledge to the organization's processes.

Phase V - Develop/Initiate Pilot Projects is the beginning of the actual implementation of the TQM process into the organization. As such it should be well planned and organized to reinforce the ideas and concepts received in training. A SPO-wide TQ Team should be formed from among voluteers from all functional areas and Directorates. They should begin their own teambuilding, come to agreement on how they want to carry out their duties (for example, meet weekly, put up Search for Opportunity boxes, agree on criteria for deciding which issues they will attempt to handle and which they will refer to the Steering Committee, how measures of improvement might be made, how to conduct needed training, etc), and carry back to their respective suborganizations that the TQM

implementation is proceeding. Each Directorate should also have its own internal TQ Committee which would work on problems concerning the processes within their Directorate and thus keep participation high.

From either these bodies or from analysis done by the management team/Steering Committee during or since their training, a small number (two or three at most) of process evaluation/correction projects should be developed and Critical Process Teams assigned to pursue them by the Steering Committee. Primary critera for selecting these early projects should include either a high probability of being able to solve the problem successfully (that is, an easy problem or one on which there is already a good consensus) or a high organization-wide interest in the problem (to maintain interest even if the solution is not immediately forthcoming). The goal here is to have a few early successes while allowing the participants to settle into their new roles and figure out productive ways of dealing with others.

A concern that will arise during this phase is the amount of time that can or should be spent doing TQM activities instead of the normal job. Often this is voiced by the middle manager who assigns work and is held responsible for timely action. This is usually not a concern of the participants who feel they have been given a new task to accomplish and should be given the time to do it also. Great care should be taken by top management in explaining to all levels that TQM is, and will be, an expected part of the job for everyone, and that all should plan to have to devote a portion of their time to it. This should be thought of as an upfront investment in time that will pay off later when process changes have improved or shortened the process.

Phase VI - Maintain Interest and Commitment is not truly a separate phase but more of an ongoing set of activities designed to keep awareness and commitment high. It becomes quite important here, however, as the first "results" from the initial projects begin to appear. A good information dissemination program is needed, perhaps the responsibility of the TQ Team itself. Information coming from their colleagues instead of from top management only will probably be accepted more readily by the organization members, especially in the early stages in which most people have not decided whether they "believe" in TQM or not. This is not to say that top management should not be disseminating information, however. Any new articles on TQM, reports on its implementation in Government or in industry, speeches by managers who have implemented it, or conferences dedicated to it should be highlighted and provided to all to read and review. Perhaps a newsletter type of publication would be useful, with plenty of contributions from the working-level members of the organization. By this time, top management should have incorporated TQM into nearly everything they do within the organization, for this actual practicing of what has been preached is the primary vehicle for letting lower level managers and workers that TQM is still in operation. This feeling should be consistently available for all to see throughout the implementation period and afterward.

Phase VII - Institutionalize Corrective Actions is where the fruits of everyone's efforts become apparant and the process is officially changed and improved. Not every action attempted will work, but many will, and these need to be documented and incorporated into the process, perhaps as an Operating Instruction or an office policy letter. These successes should also be fed into the Product Division TQM committees, for

they may be useable in other organizations facing the same problem you just solved or struggling with the same process you just improved. The TQ committee should keep some documentation of the change, including the thought process it went through in developing the fix and even some other ideas it tried but discarded. Within the SPO, there are limits as to what can be changed in the way of structure, monetary rewards, facility improvements, and other areas due to the rigidity of the government's policies and organization structure. However, that should not stop creative ideas from being presented, for flexibility seems to be increasing as TQ ideas are disseminated throughout the Air Force and DoD. Ideas not implementable now may become so later.

Phase VII - Pursue Continuous Improvement is the final step and also the first step again. It is the essence of TQM thinking, the admonition to never be totally satisfied with the process as it is, for it can no doubt be improved even further. So, while new projects will be introduced, previously fixed parts of the process should not be ignored and assumed to be perfect now. A systematic review of the overall process and subprocesses can help avoid this oversight. New people and new ideas will add to the improvement process if the desire to continuously improve is ingrained. Performance measures should be used periodically as a control device to assure the process is actually, and still, improved from its former state. If measures indicate a relapse, another round of continuous improvement may be needed.

This recommended approach for TQM implementation in program offices is generic enough to be considered for other applications as well. Phases are somewhat arbitrary, and the plan could be sliced up

differently, perhaps. The important thing is that all of the activities mentioned here be addressed, as well as others you may find necessary in your particular situation.

Analysis and Assessment of the Approach

Deming has said that it is the responsibility of management to work on the system, while the worker labors in the system. This has evolved somewhat in that TQM allows both management and the workers to evaluate and, if necessary, recommend improvements to, the process. But it remains top management's role to approve or disapprove, to make the implementing decision, and to allocate the necessary resources to allow implementation.

Just as we did not heed Deming's lessons in the 1950s and 1960s, we sometimes do not always heed them today, although we profess to build our TQM philosophy on them. What better criteria might there be than Deming's own Fourteen Obligations of Top Management withwhich to assess the "goodness" of the recommended approach above. While not written for government, service providing processes, they should nonetheless be generally valid criteria for any approach that promises enhancement of quality and productivity. Therefore, the following paragraphs will briefly review the Fourteen Obligations of Top Management introduced above in Chapter III and assess the recommended approach's satisfaction of them.

Deming's first requirement is to "create constancy of purpose toward improvement of product and service, with the aim of becoming competitive and staying in business and providing jobs." Our approach would seem to satisfy the constancy of purpose toward improvement requirement, with its continuous improvement philosophy and its reminders to maintain that attitude in the minds of management as well as the

workers. Whether our situation is aimed at competing or providing jobs or not is arguable, but our situation definately demands increased productivity, becoming competitive with our past results and beating them, and staying in business to the degree that the most inefficiently run programs will probably be the candidates for cuts and possible termination. The need for this constancy of purpose is deeply ingrained in the recommended approach.

Deming next admonishes us to "adopt a new philosophy...management must awaken to the challenge, must learn their responsibilities, and take on leadership for change." This is the basic requirement of the TQM philosophy: management must learn to think differently themselves and lead others in their learning to think differently. The first three phases of the recommended approach focus on management, their learning all they can about TQM, generating within themselves a commitment to the principles, and developing an environment where their followers can do the same. Later phases focus management's attention on maintaining interest and commitment and on pursuing continuous improvement. The recommended approach seems to heavily incorporate this obligation.

Deming's third principle tells us to "cease dependence on inspection to achieve quality. Eliminate the need for inspection on a mass basis by building quality into the product in the first place." This principle, as written, applied primarily to a production/manufacturing environment, while those in the SPO are in a paper processing service function which is quite different. But the lesson can still be applied, and is in the recommended approach. For example, the internal user concept mandates that we pass on to the next person or Directorate in the process quality output for that Directorate to use as input. Knowing what

that user needs, improving our portion of the process to better provide it, and understanding our role in the working and result of the overall process all combine to force us to do it right the first time. Also, our approach is oriented toward changing the process to see that it functions better to begin with (that is, building in quality).

Deming's next warning is to "end the practice of awarding business on the basis of the price tag. Instead, minimize total cost. Move toward a single supplier for any one item, building a long-term relationship of loyalty and trust." DoD parts company with Deming here in a large segment of its acquisitions, where by law and regulation, competition is encouraged and contract awards are made to the lowest bidder meeting the requirements specified. But in the SPO, competitive source selections are decided on a series of criteria, with cost often being a relatively minor one, after technical approach, reliability and maintainability considerations (actually quality type items), and management support. SPOs are often in the sole-source situation, and certainly, the government trys to establish a good relationship with the contractor. While our recommended approach to implementing TQM in the SPO does not address this directly, another area of ASD's TQM focus is on working with its contractors in helping them to see the advantages of TQM and introducing it into their companies also.

Deming next exhorts us to "improve constantly production and service systems to improve quality and productivity and thus decrease cost." This, of course, is the heart of our TQM plan. This thought pervades all of the philosophy management must commit to, it is at the heart of the training sessions, it is posted on the wall as one of the TQM principles, and it is specifically addressed as Phase VII which is really

the continuity of the program phase. It is also inherent in the manager's decision to invest time, effort and money now because he knows the investment in process improvement will be repaid later in higher quality and productivity.

Deming's sixth obligation of management is to "institute training on the job." Our approach addresses this on two fronts. First, TQM training is seen as vitally important for all levels in the SPO or other organization, and it is well ingrained in our approach. Second, more along the lines that Deming seemed to be talking, we recommended training once a change to the process had been implemented. The TQ Team is made responsible for training all those affected by the change in the process.

Deming next tells us to "institute leadership. The aim of leadership should be to help people and machines to do a better job." Leadership, of course, is the prime ingredient needed to get the TQM philosophy accepted by the organization. All of the phases, especially the early ones, rely heavily on top management being also the leaders in this movement, the first to demonstrate commitment, the first to actually change procedures and processes in order to create the right climate, the first to be trained, the first to think about a vision and goals, etc. The success of the implementation depends upon management being able to also be leaders.

Deming's next principle is to "drive out fear, so that everyone may work effectively." This principle is well ingrained in the recommended approach also, in the requirement that top management create a climate of involvement and participation in the TQM implementation. The entire purpose of the TQ approach is to have all members of the organization actively and creatively thinking about improving "their"

organization. Certainly, fear has no place in this motivation; people must be free to discuss the fact that the organization has problems, that many different functions may be contributing to the problem, and that solutions may change what management has previously set up as the way to do the job.

Deming's ninth principle is to "break down barriers between departments. People in research, design, sales, and production must work as a team." This important action is implemented in the many and various process teams, which incorporate people from all Directorates in the SPO to work on the overall process. The entire orientation of TQM is on cross-functional, process oriented teams, which are allowed by the TQM structural overlay that transends normal functional "stovepipes." Teamwork is a guiding principle of TQM and teambuilding is one of the important topics taught in the training sessions.

Deming next advises us to "eliminate slogans, exhortations, and targets for the work force asking for zero defects and new levels of productivity." Our approach attempts to address these in the phases dealing with developing a positive work climate and maintaining interest and commitment. The items Deming tells us to get rid of are output oriented things; our principles (which we think should be put on the wall) are oriented to the process. We are not focusing on increased out without telling the workers how to get there; we are focussing on improving the process, knowing that productivity and quality will ultimately rise as the process works better. While we do want everyone to try to do their tasks right the first time, that is different than saying we want zero defects. Given enough time, we could probably get zero defects, but lowered productivity. We want to improve the structure and sequence of the tasks

that they do, so that overall the process will become more efficient. Our call for continuous improvement leaves room for the reality that everything will not always be perfect, but that through continuous improvement, we will certainly approach it.

Deming's next principle tells us to "replace work standards (quotas) on the factory floor with leadership. Eliminate management by objective. Eliminate management by numbers. Substitute leadership." Our situation, of course, is different from the factory floor, but our implementation approach still replaces all of the condemned items above with one guiding principle: strive for continuous improvement. This, of course, will go further than goals set too low, or quotas met but never exceeded, or pursuing only those outputs measured by management. Again, our approach is not directly interested in outputs, except that they come out of an improved process.

Deming next tells us to "remove barriers that rob the hourly worker of his right to pride of workmanship. The responsibility of supervisors must be changed from numbers to quality. Abolish the annual or merit rating." In the normal course of business within DoD, many of these condemned practices have been present (and some still are). TQM is attempting to change that. Certainly, TQM will alter the supervisor's and management's orientation away from numbers (outputs, inputs) and toward quality. In the SPO environment, there are very few hourly workers, primarily secretaries. And, of course, they are also encouraged in our implementation approach to participate and help improve the processes. The sticky one is the annual appraisal, which will no doubt always be there for both civilian employees and for military officers in the SPO. But, the basis for ratings could be modified to better encourage the kind

of actions and performance required in a TQ environment. Such areas as teamwork, continuous process improvement, and participation in the TQM structure could make the appraisal system a little better. But, despite Deming's exhortations, ratings are not likely to disappear, since they are relied upon so much in the promotion and job assignment process.

Deming next suggests that we "institute a vigorous program of education and self-improvement." This is different than his previous obligation to institute training on the job, which referred more to how to do the job--job content. This is education instead of training, job context instead of content, the "why" instead of "how to." Much of what we have called TQM training falls into this category: the historical development of quality, the lessons learned from the Japanese, the philosophy and principles behind TQM, the theories on teambuilding and teamwork. In addition, the management focus on creating a climate of pride, professionalism, and excellence and the making available of new material on TQM and allied subjects encourage the continuous improvement of the individual also, not just of the work process. In the SPO, this can (and has) gone as far as having college courses presented at noontime in pertinent subjects or the encouraging of attendance at professional symposiums or of seeking professional credentials.

Deming's last principle tells us to "put everyone in the company to work on the transformation." Our approach builds on the ASD TQM principle "Give <u>everyone</u> a stake in the outcome" and encourages everyone to participate in the improvement process. Training is given to every member of the SPO, and all participate in the climate surveys. Since everyone, from clerk and secretary to System Program Director contributes

something to the process, each of their contributions should be noted and become the basis for application of the continuous improvement principle.

It seems that Deming's Fourteen Obligations of Management have been heeded, finally, in the United States and incorporated into the TQM philosophy and thus, into our recommended approach. While written primarily for a manufacturing environment, his principles have applicability beyond the factory floor, even (maybe, especially) to government service processes. While some underlying laws, regulations and policies of the government and/or acquisition arena are in conflict with a few of his exhortations (e.g., performance appraisals, award to the low bidder, barriers between departments), the philosophy and the organizational structure overlay associated with TQM do not conflict at all. Maybe we have finally learned his lessons.

CHAPTER VI

CONCLUSIONS

Chapter I posed the question for this study: what is Total Quality Management (TQM) and can it be made to work in the environment of the System Program Office within the Air Force Systems Command? Chapter II and Chapter III presented the background out of which TQM was born and traced its evolution within American and Japanese thinking. Chapter IV discussed the embracing and attempted institutionalization of TQM by the Department of Defense, Department of the Air Force, Air Force Systems Command, and Aeronautical Systems Division. Chapter V discussed some of the individual and organization structure obstacles in the System Program Office (SPO) environment, presented an eight phase approach to implementing TQM in this environment and then tested the approach by going back to the roots of the movement to see how the recommended actions matched up with Deming's Fourteen Obligations of Management.

After all of the above, we are led to the conclusion that TQM can indeed be made to work in the SPO environment. However, there are some reservations. First, top management must want for it to work and must be out front leading the implementation. But there is a lot of what might be considered top management above the level of the SPO--Product Division, Air Force System Command Headquarters, the new Program Executive Officers, Headquarters Air Force, the Secretariat of the Air Force, and all of the Office of the Secretary of Defense. All must be committed to TQM to make it work, for negative comments from any one of them will be seen by those

at the lower levels as lack of commitment. And so, we must look, at this time, to Mr Cheney and Mr Betti to send the strong signal down the acquisition chain of command that TQM should be our new philosophy. Second, managers at all levels will be increasingly under pressure to get out the work even though budgets are being cut, personnel are being decreased, and entire weapon programs are being threatened with termination. In this environment it is very difficult to allow people the time to give TQM the attention it deserves and needs to work correctly. Short term pressures may once again work to subvert the long term gains available from TQM. Third, the frequent and extensive turnover of management level personnel within all the levels above the SPO mentioned above can adversely affect the continuity of support for TQM. For each newcomer, there is likely to be, at the least, a period of time needed to gain awareness of and commitment to the philosophy, even with the proper leadership actions above them. If TQM is seen as an essential part of the new job that they must learn, along with the other aspects of job knowledge and politics, then continuity of support may not be badly eroded. In the Air Force, both General Hansen of Air Force Logistics Command and General Randolph of Air Force Systems Command, who were two of TQM's stalwart supporters in its introduction phase, have retired. The TQM banner will have to be picked up and flown high by their successors if it is to be given a chance to fullfil its promise.

Despite these potential obstacles, TQM can be made to work. To help assure its success in the acquisition community, we recommend the following:

1. DoD, Air Force, and Systems Command officials should reemphasize their support for TQM with appropriate policy letters

emphasizing quality and productivity improvements to the process as a means of dealing with the budgetary and personnel challenges facing the DoD:

2. Headquarters Air Force Systems Command should consider the potential benefits of selecting one consulting firm or educational institution to provide TQM training to all of the Product Divisions. This may result in a lower overall cost and should result in a standardized presentation of material that would allow personnel to transfer within the Command and to step right into a familiar TQM environment at the new base:

3. Product Division Commanders should encourage TQM pursuits in every SPO and functional Deputy and set the tone by implementing an enthusiastic program at the Product Division level. Emphasis should be on making the quality culture, and all that it implies, a way of life at that Product Division;

4. System Program Directors should consider the implementation plan recommended above and tailor it to meet their specific needs. They should also expedite the training of their people, especially initial training to assure all personnel are aware of the potential of the philosophy; and

5. DoD and Air Force officials should require the preparation and presentation of an appropriate length block of training or education in every technical and management oriented course which acquisition personnel normally take. This would include all courses at the Air Force Institute of Technology, the Defense Systems Management College, and the Air Force Systems Command Acquisition Management

School. The exposure to the concepts, the discussion among students of various backgrounds, and the application of the concepts to the subject in which the instruction is embedded will serve to reinforce the importance of and need for thinking about the TQM principles.

It would seem that Total Quality Management has come along at exactly the right time to help the DoD and the services' acquisition organizations to "do more with less" as they have been, and will be, asked to do. Whether we will be observant enough to notice that it could be a big help to us and whether we will have the top management support for its implementation remain the major unanswered questions. The philosophy and principles of TQM have turned around other organizations; we need to give it a chance to do the same for the Air Force.

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